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THE PLANT DISEASE SURVEY

Division of Mycology and Disease Survey

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

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THE PLANT DISEASE REPORTER

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THE PLANT DISEASE SURVEY
DIVISION OF MYCOLOGY AND DISEASE SURVEY

Plant Industry Station
Volume 31

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FUNGI ASSOCIATED WITH ROOT LESIONS OF THE STRAWBERRY IN OREGON[1]

P. W. Miller[2]

Many strawberry growers in western Oregon have sustained serious losses of plants and decreased yields from root troubles. One of the more important root diseases present in the State is brown-core root rot, or the red stele disease as it is known elsewhere. This disease is due to the fungus Phytophthora fragariae which lives in the vascular tissues of the stele, or central cylinder, producing a brown discoloration of this "core".

In addition to this disease, there are other root troubles which affect the cortical tissues but not the core. Plants so affected appear dwarfed or stunted in comparison with healthy, normal plants. The leaves and petioles are reduced in size and the foliage turns a bronzy or reddish-brown color in early summer and the plant eventually dies.

These symptoms in the above-ground parts of plants result from physiological drought and starvation, brought about by the progressive dying of the root system.

Dark-brown to black lesions occur both on the somewhat fleshy primary roots and on the fibrous secondary roots. The lesions are at first localized, occurring at any point along the root. Later, the entire root system is involved, the fibrous secondary roots decaying first, leaving only the long primary roots, which eventually also rot away.

This black root condition is widely distributed in western Oregon, occurring to a greater or less extent in practically all strawberry plantings in the western part of the State. However, this trouble is

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2 The helpful assistance of Dr. S. M. Zeller, plant pathologist at Oregon State College, in identifying a number of fungi isolated from the crowns and lesions on the roots of affected plants is gratefully acknowledged.

by no means confined to the State of Oregon; the same or a very similar root disorder has been reported from England (3), Canada (2, 7, 20), Australia (1), Africa (10), Rhodesia (8), and from the following States: Michigan (5, 16, 17), Florida (4), Tennessee (15), California (18, 19), New Jersey (9), Louisiana (12, 13), Washington (6), and Utah (14, 21).

The cause of this disorder has been ascribed to various agencies including soil organisms and such adverse environmental factors as winter injury, unfavorable soil conditions, and toxins in the soil (6).

Adverse storage conditions and poor handling of plants prior to planting are definitely known to be responsible for a black root condition in Oregon (21).

Numerous organisms have been reported as being associated with strawberry root troubles. In England, Leptosphaeria coniothyrium (Coniothyrium fuckelii), Fusarium orthoceras, Cylindrocarpon radicicola, Pachybasium candidum, and Pezizella lythri (Hainesia lythri) were reported to be able to produce lesions on the roots (20). Leptosphaeria coniothyrium and Pezizella lythri were also found associated with a strawberry root rot in Michigan, in addition to Rhizoctonia (5, 16, 17). Rhizoctonia was also reported as being found in root lesions on plants grown in California (18, 19), Utah (21), Washington (6), and Oregon (21). In Canada (Ontario) species of Pythium, Ramularia, Alternaria, Verticillium, Cylindrocladium, Rhizoctonia, Asterocystis, plasmodiophoraceous fungi, and a phycomycetous mycorrhizal fungus were found present in root lesions (20).

Hildebrand (7) reported that the microscopic examination of root lesions of strawberry plants grown in Canada (Ontario) showed the presence of an "endophytic mycorrhizal fungus," two forms of Rhizoctonia, Asterocystis, Pythium spp., Ramularia, and nematodes. In Utah, isolations from black root rot lesions most commonly gave Fusarium orthoceras, species of Rhizoctonia, Cylindrocarpon, Hainesia, and Coniothyrium, Olpidium brassicae, and a phycomycetous mycorrhizal fungus (14, 21). In Louisiana, Plakidas (12, 13) also reported a Pythium as the cause of a root rot of strawberries. Nolan (11) reported a Diplodia as being the cause of a root rot disease of strawberries. Zeller (21) reported that Rhizoctonia solani is the primary cause of a root rot of strawberries in Oregon and proved the pathogenicity of the organism by inoculation.

Species of Rhizoctonia, Fusarium, Actinomyces, Pythium, Coniothyrium, and other fungi have been reported as being associated with a root rot of strawberries in other countries (8, 10).

It is evident from the above that a wide variety of fungi have been found associated with root lesions on strawberries in various locations.

The heavy loss of plants and the decreased yields sustained by Oregon strawberry growers from root troubles in recent years has prompted them to call for further investigation of their cause and control. In this paper are reported the results of pertinent studies carried on by the writer in cooperation with the Oregon Agricultural Experiment Station during 1945 and 1946.

The investigations have consisted primarily of (a) extensive isolations from the crowns and lesions on the roots of affected plants collected from different plantings in widely scattered districts of western Oregon and (b) tests of the pathogenicity of the microorganisms isolated.

Isolation Studies

Methods

Crown and root pieces containing definite lesions bordered by turgid, healthy tissues were surface sterilized in 0.5% sodium hypochlorite solution for about 5 minutes and then transferred directly to plates of potato-dextrose agar (pH 5.6).

Results

1945 Studies. Isolations made from 1,341 root lesions from infected plants yielded representatives of 19 identified genera of fungi and other unidentified genera. Isolations from 200 lesions in the crowns yielded representatives of 14 identified genera of fungi and other unidentified genera. In table 1 are given the identified fungous genera isolated and the comparative frequency of their occurrence.

1946 Studies. Isolations made from 751 root lesions from infected plants yielded representatives of 19 identified genera of fungi, a number of other unidentified genera, and one species of nematode. Isolations from 133 lesions in the crowns yielded representatives of six identified genera of fungi and other unidentified genera. In table 2 are listed the identified genera isolated and the comparative frequency of their occurrence.

It is evident from a study of the data given in tables 1 and 2 that no specific fungus is associated constantly or alone with root lesions on strawberries under Oregon conditions but rather a number of different organisms are involved. Moreover, there is considerable variation in the fungi predominating in the lesions when the plants are grown under different conditions. While no one fungus predominates under all conditions, it is nevertheless true that the fungi commonly found in the lesions under most conditions are an associated group. Included in this associated group of fungi are the following: Ramularia spp., Rhizoctonia spp., Fusarium spp., Chaetomium spp., Penicillium spp.,

Table 1. Fungi isolated from lesions in the crown and on the roots of strawberry plants[a] from 8 fields in western Oregon in 1945, and the comparative frequency of their occurrence.

Fungi isolated	Part of host from which isolations were made	Total number of lesions from which isolations were made	Percentage of root lesions from which fungus in question was isolated
Ramularia spp.	roots	1341	24.8
Rhizoctonia spp.	..do..	..do..	6.2
Fusarium spp.	..do..	..do..	5.7
Oothecium spp.	..do..	..do..	4.2
Chaetomium spp.	..do..	..do..	3.5
Penicillium spp.	..do..	..do..	3.5
Phycomycetes[b]	..do..	..do..	2.2
Rhizopus spp.	..do..	..do..	1.2
Mucor spp.	..do..	..do..	1.1
Stemphylium spp.	..do..	..do..	0.9
Pestalotia spp.	..do..	..do..	0.9
Verticillium spp.	..do..	..do..	0.8
Phoma spp.	..do..	..do..	0.4
Dicoccum spp.	..do..	..do..	0.3
Isaria spp.	..do..	..do..	0.2
Botrytis sp.	..do..	..do..	0.2
Gloeosporium spp.	..do..	..do..	0.1
Mycogone sp.	..do..	..do..	0.1
Hormodendron sp.	..do..	..do..	0.1
Undetermined miscellany	..do..	..do..	43.5
Penicillium spp.	crown	200	30
Fusarium spp.	..do..	..do..	12
Verticillium spp.	..do..	..do..	10
Mucor spp.	..do..	..do..	10
Rhizoctonia spp.	..do..	..do..	5
Chaetomium spp.	..do..	..do..	3
Pestalotia spp.	..do..	..do..	3
Rhizopus spp.	..do..	..do..	3
Botrytis spp.	..do..	..do..	2
Phycomycetes[b]	..do..	..do..	1
Alternaria sp.	..do..	..do..	0.5
Oothecium sp.	..do..	..do..	0.5
Stemphylium sp.	..do..	..do..	0.5
Ramularia sp.	..do..	..do..	0.5
Undetermined miscellany	..do..	..do..	19.0

[a] The varieties Corvallis, Redheart, Marshall, and Oregon No. 1775

[b] *Phytophthora* spp. and *Pythium* spp.

Table 2. Organisms isolated from lesions in the crown and on the roots of strawberry plants[a] from 8 fields in western Oregon and Washington in 1946 and the comparative frequency of their occurrence

Fungus isolated	Affected plants grown in:	Part of host from which isolations were made	Total number of isolations made	Percentage of root lesions from which organism in question was isolated
Chaetomium spp.	greenhouse[b]	roots	227	28.6
Ramularia spp.	..do..	..do..	..do..	19.0
Penicillium spp.	..do..	..do..	..do..	5.3
Fusarium spp.	..do..	..do..	..do..	5.2
Oothecium	..do..	..do..	..do..	3.1
Phycomycetes[c]	..do..	..do..	..do..	2.9
Rhizoctonia spp.	..do..	..do..	..do..	1.7
Stemphylium spp.	..do..	..do..	..do..	1.3
Alternaria spp.	..do..	..do..	..do..	0.8
Cladosporium sp.	..do..	..do..	..do..	0.4
Pestalotia sp.	..do..	..do..	..do..	0.4
Nematodes	..do..	..do..	..do..	0.4
Undetermined miscellany	..do..	..do..	..do..	30.9
Chaetomium spp.	field	roots	391	12.3
Ramularia spp.	..do..	..do..	..do..	11.8
Penicillium spp.	..do..	..do..	..do..	10.4
Fusarium spp.	..do..	..do..	..do..	6.1
Phycomycetes[c]	..do..	..do..	..do..	5.9
Rhizoctonia spp.	..do..	..do..	..do..	4.3
Pestalotia spp.	..do..	..do..	..do..	2.8
Mucor spp.	..do..	..do..	..do..	2.3
Oothecium spp.	..do..	..do..	..do..	1.5
Coniothyrium spp.	..do..	..do..	..do..	1.0
Rhizopus spp.	..do..	..do..	..do..	0.3
Gloeosporium spp.	..do..	..do..	..do..	0.3
Phoma spp.	..do..	..do..	..do..	0.1
Isaria sp.	..do..	..do..	..do..	0.1
Verticillium sp.	..do..	..do..	..do..	0.1
Botrytis sp.	..do..	..do..	..do..	0.1
Nematodes	..do..	..do..	..do..	0.1
Undetermined miscellany	..do..	..do..	..do..	40.2
Penicillium spp.	field	crown	133	13.5
Ramularia spp.	..do..	..do..	11	2.2
Fusarium spp.	..do..	..do..	..do..	1.5
Mucor spp.	..do..	..do..	..do..	1.5
Rhizoctonia	..do..	..do..	..do..	0.7
Chaetomium spp.	..do..	..do..	..do..	0.7
Undetermined miscellany	..do..	..do..	..do..	79.9

[a] The varieties Marshall, Pitt, and miscellaneous Oregon hybrids.

[b] Plants grown in field soil in greenhouse bench.

[c] Phytophthora spp. and Pythium spp.

Phycomycetes, Verticillium spp., Oothecium spp., and Pestalotia spp.

Other fungi occasionally isolated were Phoma spp., Coniothyrium spp., Rhizopus spp., Stemphylium spp., Dicoccum spp., Isaria spp., Botrytis spp., Gloeosporium spp., Alternaria spp., Cladosporium spp., Aspergillus spp., Mucor spp., Mycogone spp., Hormodendron spp., and Septoria spp.

Pathogenicity Studies

The pathogenicity of representatives of all of the identified genera isolated was tested under greenhouse conditions.

Methods

In most cases the fungus was grown on sterilized sweetclover stems in test tubes for one to two months at room temperature after which the inoculated stems were forced into the soil alongside the crowns of healthy plants growing in pots of pasteurized soil. In certain instances, the fungus was grown on sterilized wheat or oat kernels for 1 to 2 months and the inoculum mixed with pasteurized soil prior to planting. In certain cases the roots of the plants were dipped in a spore suspension of the fungus before planting.

The inoculated plants were incubated in the greenhouse at room temperatures, ranging from 60° to 70°F. In one series, the plants were incubated at a higher soil temperature, ranging from 75°F. to 80°F.

After about two months, the roots of the inoculated plants were washed out and examined for the presence of lesions. Reisolations were made from lesions on a representative number of inoculated plants to check upon the identity of the organisms present.

Results.

The results of pathogenicity studies carried on are summarized in Table 3. It would appear from a study of the data given in this table that under the conditions of this test a number of organisms can infect the roots and produce lesions.

The two most pathogenic fungi under these conditions were Rhizoctonia spp. and Ramularia spp. Other feebly or less pathogenic fungi were Stemphylium spp., Phytophthora spp., Fusarium spp., and Verticillium spp.

Table 3. Studies on the pathogenicity of various fungi isolated from lesions on the roots of strawberry plants affected with black root. 1945-1946.

Fungus	Total number of plants inoculated	Results of inoculation: Inoculations positive No.	Inoculations positive Percent	Relative abundance of lesions on root systems of infected plants: Few lesions Percent	Moderate number of lesions Percent	Many lesions Percent	Great many lesions Percent	Results of reisolations: Original fungus reisolated in indicated percent of reisolation attempts
Rhizoctonia spp.	62	53	85.4	16.9	45.2	37.7	0	72.7 (24/33)[a]
Ramularia spp.	92	76	82.6	13.1	56.5	27.6	2.6	47.6 (20/42)
Stemphylium spp.	11	9	81.8	0	66.6	33.3	0	16.6 (1/6)
Phycomycetes[b]	15	12	80	8.4	50	41.6	0	12.5 (1/8)
Fusarium spp.	50	39	78	20.5	51.2	23	5.1	10 (2/20)
Verticillium spp.	32	27	84.3	22.5	48.1	29.6	0	5.9 (1/17)
Dicoccum sp.	1	1	100	0	0	0	100	100 (1/1)
Pestalotia spp.	13	8	61.5	12.5	50	37.5	0	0 (0/6)
Phoma spp.	6	6	100	0	66.6	16.6	16.6	0 (0/4)
Oothecium spp.	2	1	50	100	0	0	0	0 (0/1)
Botrytis spp.	2	2	100	0	50	50	0	0 (0/1)
Mycogone sp.	1	1	100	0	100	0	0	0 (0/1)
Gloeosporium sp.	1	1	100	0	100	0	0	0 (0/1)
Alternaria sp.	1	1	100	0	0	100	0	0 (0/1)
Coniothyrium sp.	1	1	100	0	100	0	0	0 (0/1)
Isaria sp.	1	1	100	0	0	100	0	0 (0/1)
Cladosporium sp.	1	0	0	0	0	0	0	0 (0/1)

[a] Denominator = total number of attempts; numerator = number of times original fungus was isolated.

[b] Phytophthora spp. and Pythium spp.

Discussion

From the foregoing it is evident that no one specific fungus is associated constantly or alone with root lesions on strawberries under Oregon conditions, but rather a complex of fungi and possibly other organisms is involved, with no one organism standing out as being of paramount importance. As is to be expected in a complex root rot of this type, in which the fungi concerned are primarily facultative parasites, the associated group of organisms is not always the same, since the soil flora is affected by differences in soil type, temperature, moisture, pH reaction, and other factors of environment.

That the soil environment in which plants are grown plays an important role in the development of root rot diseases in general is a well-established fact. As is the case with most other root rot diseases, the development of strawberry root rot is favored by excess of moisture in the soil. The reason for this is that the growth of most soil fungi is favored by abundant soil moisture whereas the roots of strawberries and most other crop plants are adversely affected by the same condition, since roots in general require good aeration to function normally. Then too, there is some evidence to indicate that in waterlogged or poorly drained soils toxins tend to accumulate, which would doubtless increase the susceptibility of the host and encourage root rot attack.

In assessing the various factors that are involved in the development of root rot it must be remembered that roots grow in a living, dynamic environment of a most complex nature. Any influence that upsets the normal biological balance in the soil is likely to affect not only the soil flora but the host plant as well. A study of root rot diseases of the complex type should therefore go much further than a mere study of host-parasite relationships. The chemical, physical, and biological interrelationships must also be included before a clear understanding of this complicated problem can be had.

Summary

Investigations on the fungi associated with root lesions of strawberries carried on from 1944 to 1946 indicate that no specific fungus is associated constantly or alone with strawberry root rot under Oregon conditions, but rather a number of different fungi are involved. The fungi most commonly found associated with the root lesions were the following: Ramularia spp., Rhizoctonia spp., Fusarium spp., Chaetomium spp., Penicillium spp., phycomycetous fungi (Phytophthora spp. and Pythium spp.) Verticillium spp., Cothecium spp., and Pestalotia spp.

Other fungi occasionally isolated were Phoma spp., Coniothyrium spp., Rhizopus spp., Stemphylium spp., Dicoccum spp., Isaria spp., Botrytis spp., Gloeosporium spp., Alternaria spp., Cladosporium spp., Aspergil-

lus spp., Mucor spp., Mycogone spp., Hormodendron spp., and Septoria spp.

In the pathogenicity studies, Ramularia and Rhizoctonia were found to be the most pathogenic of the genera tested. Feebly pathogenic fungi were Stemphylium spp., Phytophthora spp., Fusarium spp., and Verticillium spp.

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INTERNAL BARK NECROSIS (MEASLES) OF DELICIOUS APPLE IN NEW YORK IN RELATION TO pH, MINOR ELEMENT TOXICITY, AND NUTRIENT BALANCE OF SOIL

E. M. Hildebrand

Introduction

The non-parasitic apple measles, described by Berg (1934) as "Internal bark necrosis", is a bark disease of physiogenic origin that attacks a relatively small number of varieties, of which the Delicious is most important. The author studied internal bark necrosis from 1933 to 1944 as it occurred on Red Delicious in New York State. Young and Winter (1937) induced a more diffuse type of internal bark necrosis on Delicious apple by withholding boron from nutrient solution in sand culture experiments. Field and sand-culture experiments by the author (5) supported the work done in Ohio (6), but there were exceptions where this bark disease of Delicious failed to respond to boron applications. One exception, an orchard in Niagara County, New York from which century-old trees had been removed in 1937, forms the basis for this report.

The planting of a young apple orchard, including Rome Beauty, McIntosh, Red and Golden Delicious, in the interspaces between the locations of the old trees was done in 1937. By 1940 a number of Red Delicious trees had died, even though barnyard manure, a supplier of boron, had been applied in 1939. All dead and dying trees were promptly replaced, but severe bark symptoms, stunting, and death continued to occur. The peculiar behavior of the trees on a rich silt loam soil invited a basic study of the soil, which had supported good Baldwin and Rhode Island Greening apple tree growth for over a century. One fact bears stating here -- that where boron had corrected the internal bark necrosis condition on Delicious trees of all ages in other

orchards, the soil was usually sandy loam with a pH well above 5.0.

Symptoms

Internal bark necrosis begins in association with the phloem tissue of the bark as a phloem necrosis. Before their death the cells surrounding the deficient cells are stimulated to meristematic activity. When death follows it proceeds outward from the focal center resulting in necrotic areas spherical in shape that may become confluent forming ever larger dead patches of irregular shape which extend to the surface by the second season following their initiation. The small necrotic areas usually start to form toward the end of the first season's growth and become visible at the surface as little convex spots during the second season in the two-year-old growth. The necrotic spots can be seen early in the second season in cross-sections of the stem and have neither internal nor external connections. Thus small spherical lesions, which start with hyperplasia and follow through the stages of enlargement, fusion into larger areas and death, end their development as a type of bark canker, involving as much as one-half the trunk of a large bearing tree and extending from the new growth to below the ground line of the trunk.

Experimental Results

The experimental work involved the testing of a number of approaches designed for the diagnosis of the soil complex associated with the occurrence of internal bark necrosis in Delicious apple trees.

pH of Soil. Soil samples were taken from around all 14 trees in Row 4 both in 1943 and 1944 and tested for pH. From these analyses it can be concluded that the pH varied from 3.8 to about 5.0 for trees showing internal bark necrosis symptoms. The lone symptomless tree was number 8, which had a soil pH of about 7.0. Lack of time prevented the making of similar readings for all the trees in the orchard. However, the soil from around two diseased trees in each of the other five rows gave pH's corresponding to those in Row 4.

Boron and Nitrogen Applications. Early in 1943 every other (odd-number) young Delicious tree received one or two ounces of borax scattered broadcast over about one square yard of surface area. At the same time the same soil area around every Delicious tree received between 4 and 5 ounces of ammonium sulphate nitrogen.

Biological Assay for Boron. No marked growth or symptom response followed the application of boron and nitrogen fertilizer to the soil around the Delicious trees in the early spring of 1943. However, through the courtesy of Dr. R. F. Chandler, Jr., a biological assay was made during the winter of 1943-1944 of composite soil samples

taken from around trees 8(-B), 9(+B), and 10(-B) in Row 4. The pH's of these soil samples were, respectively, 7.1, 4.4, and 4.45. The Colwell assay technique employed involved planting sunflower seed in cans containing 100 gram soil samples in triplicate, diluted by sand, to which a full nutrient solution was supplied, minus boron.

At the end of 20 days from planting of the sunflower seed, boron deficiency symptoms were showing for the soil sample taken from around tree 10. When terminated at 40 days the symptoms were very pronounced. The sunflower plants growing in the soil from around tree 8, the normal tree, which likewise had received no boron, were normal as also were the sunflower plants grown on soil taken from around tree 9, that had received boron. Thus, correlated with the severe internal bark necrosis symptoms on tree 10, growing on soil that had not received boron, was a deficiency of the minor element boron.

Soil Analyses - Series A. Composite soil samples, each consisting of 8 subsamples, were taken from around a number of severely affected trees in 1943. The chemical soil analyses were made by Dr. Michael Peech, Soils Chemist. The first, or A series, analyzed was taken from around 4 trees, all severely affected. The analyses are summarized in table 1.

Table 1. Pounds per acre (in 2,000,000 pounds of soil) of the chief major and minor elements in soil taken in 1943 from around severely diseased Red Delicious trees.

Series No.	Row No.	Tree No.	Soil pH	P	N	Ca	Mg	K	Mn	Fe	Al
A	4	3	4.20	19	130	400	25	260	90	90	230
		4	4.40	20	105	300	25	175	50	65	220
		9	3.95	20	115	150	15	210	125	60	250
		10	4.15	20	125	200	20	175	125	85	200

The very low calcium and magnesium contents of the soil undoubtedly accounted for the low pH's from 3.95 to 4.40. The levels of potassium, nitrogen, and phosphorus indicated good fertility but the potassium was high. The manganese, iron, and aluminum contents were high suggesting toxic levels. On closer examination it will be noted that the manganese levels were significantly higher for trees 9 and 10 than for 3 and 4, whereas the symptoms were definitely worse in the latter. In brief, the soil from around the severely diseased trees was extremely acid; very low in bases; and had toxic amounts of aluminum, iron and manganese.

Soils Analyses - Series B. Two months later another chemical analysis series was run of composite soil samples taken from around

typically diseased trees in two sections of the orchard where the symptoms were severe. In Row 4, among the severely diseased trees, stood an apparently healthy Red Delicious tree. The grower knew no reason for this occurrence. However, there were a number of symptomless and apparently normal trees growing in other parts of this orchard (see table 4). The results of the chemical soil analyses are summarized in table 2.

Table 2. Pounds per acre (in 2,000,000 pounds of soil) of the chief major and minor elements in soil taken from around representative Delicious trees.

Series No.	Row No.	Tree No.	Soil pH	P	N	Ca	Mg	K	Mn	Fe	Al
B	4	7	4.20	18	28	300	25	225	60	50	200
		8	7.10	100	35	5250	170	600	45	1	18
		9	4.40	20	40	300	25	225	110	50	200
		10	4.45	18	32	200	25	185	135	70	200
	9	7	5.20	10	15	700	50	285	45	15	150
		8	5.05	15	17	600	40	225	70	20	130

The soil from around the healthy tree Number 8 showed chemical analyses distinct from any of the adjacent Red Delicious trees. Its soil pH was approximately neutral (7.10), compared to pH 4.35 for the three adjacent diseased trees, 7, 9, and 10. Quantitatively, the soil from around the diseased trees contained about 5 percent as much calcium and 14 percent as much magnesium as the soil around the healthy tree. All the minor elements were in much greater quantity around the diseased trees as a glance at table 2 will show. The quantities of the minor elements manganese, iron, and aluminum in the soils around the diseased trees were, respectively about 2, 50, and 11 times as great as around the healthy tree. The healthy tree had a trunk girth of 15 3/4 inches compared to an average of 6 1/4 inches for the three adjacent diseased trees.

Analyses of the soil from around trees 7 and 8 in Row 9 in another part of the orchard gave a higher pH of about 4.80. The soil content of calcium and magnesium (table 2) was above that for the other diseased trees and showed corresponding reductions in the minor elements manganese, iron, and aluminum. The trunk girths of these trees were, respectively, 8 and 2 inches. The latter was a replant made one year previously but was not doing well and was already showing symptoms.

These observations have made it rather obvious that the first step in correcting the sick soil condition in this orchard should be the

application of both calcium and magnesium lime. By correcting these deficiencies the pH levels will be raised and this will in turn correct for the high toxic levels of the minor elements by taking them out of solution.

Soil Analyses - Series C. A more extensive series of soil analyses was made following the application of high calcium lime at the rate of one ton to the acre to the soil around certain trees. These data are well illustrated by the readings taken from representative trees 9 and 10 in Row 4. (Table 3).

Table 3. Pounds per acre (in 2,000,000 pounds of soil) of the chief major and minor elements in soil taken from around representative affected Delicious trees that had received lime applications at the rate of 1 ton per acre about 3 months previously.

Series No.	Row No.	Tree No.	Soil pH	P	N	Ca	Mg	K	Mn	Fe	Al
			Before Liming								
C	4	9	4.4	20	40	300	25	225	110	50	-
		10	4.45	18	32	200	25	185	135	70	-
			After Liming								
C	4	9	4.7	22	30	2200	25	285	100	35	-
		10	6.0	22	45	3200	30	300	125	42	-

In most cases the pH was raised about one unit from slightly above 4.00 to above 5.00 within three months from time of application of the lime. Although reduced in amount, the quantities of the minor elements, manganese and iron were still at toxic levels. No doubt more change will occur with time. Also some magnesium lime is indicated as needed by the data in the table showing magnesium deficiency after liming.

Girth Measurements and Symptoms. Girth measurements and symptom severity were recorded annually. A brief summary of conditions at the end of 6 years and again at 7 years from planting is given in table 4.

Table 4 gives the growth and symptom story for Delicious apple trees affected with internal bark necrosis during the sixth and seventh years from planting. Rows 1, 5, 6, 10 and 11 were planted to Rome Beauty and rows 3, 8 and 13 to McIntosh. A glance at the table will reveal the location of a relatively few apparently healthy trees. The healthy trees were always the largest in girth and most normal in appearance. The trees with very small girths of 3 inches or less represent replants that have usually been made within 2 years time. Trees

Table 4. Map showing girth (in inches) and symptom severity (M1 to M5) of the Red Delicious (Rows 2, 4, 7, 9, 12) and Golden Delicious (Row 14, all but tree number 11) six and seven years from planting. OT means old tree still standing.[a]

Trees	Year	Girth in inches and symptoms for 1943 and 1944 on Red Delicious (Rows 2, 4, 7, 9, 12; Row 14, tree 11) and Golden Delicious (Row 14)													
		14	13	12	11	10	9 OT	8	7	6	5	4	3	2	1
1	1943	8 1/4-?		9 1/4-M3			12 1/2-?M		6-M2		8	1/2-M3		10 3/4-M3	
	1944	8 3/4-?		9 1/2-M3			13 - ?M		6-M2		8	3/4-M3		11 1/2-M3	
2	1943	8 1/8-?		9 1/2-M1			18 1/4-0		2 OT 3/4-M5		9	3/4-M1		3 1/4-M1	
	1944	8 - Sick		9 3/4-M1			18 3/4-0		3-M5 OT		10	1/4-M1		3 1/2-M1	
3	1943	11 - ?		17 3/4-0			12 3/4-?M		3 OT 3/4-M4		5	1/4-M5		4 1/2-M3	
	1944	11 1/2-?		18 -0			13 1/4-?M		4 1/2-M4		6	1/2-M5		4 1/2-M3	
4	1943	14 1/4-0		18 -0			15 -0		10 1/4-M3		4	3/4-M4		8 7/8-M4	
	1944	15 -0		18 1/4-0			15 1/4-0		10-M3		5	-M4		9 1/2-M4	
5	1943	12 1/8-0		10 1/2-M2			10 -M1		9 1/2-M1		3	1/2-M2		6 1/4-M2	
	1944	12 3/4-0		11 1/4-M2			10 1/4-M1		9 3/4-M1		3	5/8-M2		7 -M2	
6	1943	10 1/2-0		6 1/4-M2			3 -M1		8 3/4-M2		8	3/4-M4		3 1/4-M5	
	1944	10 3/4-0		6 3/4-M2			3 -M2		9 1/4-M2		9	-M4		3 1/2-M5	
7	1943	9 3/4-0		15 1/2-0			7 3/4-M2		7 -M4		8	1/2-M5		6 -M2	
	1944	9 3/4-M		16 -M1			8 -M2		7 1/4-M4		8	3/4-M5		6 1/2-M2	
8	1943	8 -M2		16 1/4-0			2 -0		9 3/4-M1		15	3/4-0		8 -M4	
	1944	8 1/2-M2		17 -0			2 -M1		10 -M1		16	1/2-0		8 1/2-M4	
9	1943	8 1/4-M2		6 3/8-M5			7 1/2-M3		7 3/4-M2		6	1/4-M3		9 1/2-M4	
	1944	8 3/4-M2		6 3/4-M5			7 1/2-M3		8 1/4-M2		6	3/4-M3		10 -M4	
10	1943	11 1/4-0		8 1/2-M3			10 3/4-M1		3 -M2		4	-M4		11 3/4-M3	
	1944	11 3/4-0		9 -M3			11 1/4-M1		3 1/4-M2		4	1/4-M4		12 -M3	
11	1943	16 1/4-0		6 1/4-M2			4 1/4-M5		1 1/2-0		10	3/4-M4		8 1/4-M4	
	1944	16 1/2-0		6 1/2-M2			4 1/4-M5		2 -M2		11	-M4		8 1/2-M4	
12	1943	-		8 1/4-M4			13 -0		9 3/4-M2		4	-M3		2 -?0	
	1944			8 1/2-M4			13 1/2-M1		10 -M2		3	3/4-M3		2 1/4-M1	
13	1943	-		-			-		-		6	1/2-M4		7 3/4-M4	
	1944										6	3/4-M4		8 1/4-M4	
14	1943	-		-			-		-		10	1/4-M1			
	1944										10	3/4-M1			

[a] The girth measurements were made at a height of about 18 inches above ground level in early spring. Bark symptoms were recorded at the same time -M1 being the earliest stage of bark symptoms and M5 the most severe stage including dieback.

12 in row 2, 11 in row 7, and 8 in row 9 were planted in 1942. Thus symptoms, although not showing within the first year in 1943, were showing in 1944.

The table is presented in the form of a map of the orchard to show the relative position or location of the trees. The experimental error in taking the tree girth readings was found to be about 1/8 inch ±. Therefore only the girth increases of over one-fourth inch are significant. It will be noted that three old trees (OT) are still standing. That the young trees were planted in the interspaces is indicated by the position of the old trees. The extremely severe symptom picture presented by this orchard was the inspiration for presenting these data for others to see. The termination of the author's work in this orchard during the summer of 1944 came at the time the first liming applications were beginning to take effect. These studies are being continued by my former colleague, Dr. Damon Boynton.

Discussion and Conclusions

The internal bark necrosis disease of Red Delicious in the selected orchard under study has indeed a complicated background of causation involving calcium and magnesium deficiency; adequate nitrogen, phosphorus, and potassium, with the latter in excess; toxic levels of manganese, iron, and aluminum; and boron deficiency.

In retrospect, the low pH of the soil was the key to a recognition of the complexity of the causal mechanism. Whether applications of calcium and magnesium limes will also contain enough boron to correct that deficiency remains to be seen. It is significant that this study involved soil that is considered ideal for apple trees and has been continuously in use for growing apples for over a century. Planting young trees limits the feeding range of their roots to a shallow surface layer and it is apparently in this layer that the deleterious spray residues are also being accumulated with the years. It is possible that the low soil pH was the result of calcium and magnesium depletion by the trees plus the addition of sulfur spray residues. This is only a guess, however.

The recent outstanding work by Berg and Clulo (2, 3,4) has demonstrated that manganese toxicity is a factor in the cause of internal bark necrosis (apple measles) under the soil conditions obtaining in West Virginia. They have also indicated that excess of the minor element iron was also important in the development of the disease. Of great significance was the fact that the pH of the soils conducive to its development was very low (4.2). Also the addition of lime decreased the acidity from pH 4.2 to 6.5 and thereafter prevented the development of the internal bark necrosis symptoms.

In an earlier report (5) the application of boron stimulated a

marked increase in terminal growth of Red Delicious trees receiving nitrogen in orchards where the internal bark necrosis symptoms were also controlled. In this report no responses were observed from fertilizing with both nitrogen and boron. Also no mention has been made on the growth of the other varieties except Golden Delicious where two trees definitely showed internal bark necrosis symptoms. Previously bark symptoms had not been observed on Golden Delicious. However, table 4 shows several Golden Delicious trees that were not growing well. Abnormal leaf characteristics were noted for all the varieties and especially for the trees that were not doing well. Time was not afforded for any detailed examination into the situation except as it involved the bark symptoms. This study demonstrates the vital importance of soil chemistry in relation to the study of control measures for the physiogenic diseases of plants.

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OBSERVATIONS ON CITRUS DISEASES IN CHINA

Lin, Kung-Hsiang

During a citrus disease survey trip to Fukien and Kiangsi Provinces in the fall of 1941, and a visit to Szechuan Province in 1943, the writer found evidence of 20 citrus diseases, 12 of which are of major importance in one place or another, the rest of negligible or minor importance. The following is a brief report on the observations made on these diseases.

Of major importance

Scab (Pathogen: Elsinoë fawcettii). This disease is most severe on Citrus tangerina Hort. ex Tanaka, C. poonensis Hort. ex Tanaka, and C. grandis (Linn.) Osbeck in Fukien, and on C. kinokuni Tanaka in Nanfeng, Kiangsi, but is mild on C. tangerina in Chengtu and Chingtang, Szechuan. The effect of air moisture on this disease is most obvious in Fukien. In those orchards where the trees are closely planted (usually about 10 to 12 feet apart) and thus poorly ventilated, the disease is particularly serious. Young orchards usually are free from this disease and bear healthy good-looking fruits, but as the trees grow older the fruits become scabby. The growers ascribe this to the old age of the tree, while in fact it is due to the attack by the scab pathogen as a result of more favorable conditions for infection as the trees grow larger and become overcrowded.

Canker (Pathogen: Phytomonas [Xanthomonas] citri). This disease severely affects Citrus sinensis (Linn.) Osbeck, C. tankan Hayata, and C. limon (Linn.) Burm. in Fukien. The writer also found it on a few trees of C. grandis, and in a young orchard of C. limon in Nanfeng, Kiangsi. But strangely enough the disease is absent in Chengtu and Chingtang, Szechuan, where susceptible species of Citrus are grown and the climatic conditions are favorable for the development of the disease.

A Bark Disease of Unknown Cause[1]. It is suspected that this disease is related to the scaly bark disease (psorosis) found on Citrus sinensis in California, which is caused by a virus. The disease attacks only C. tangerina and commonly occurs in Foochow and Chiangchow districts of Fukien Province, but has not been seen by the writer in Kiangsi and Szechuan.

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[1] Note by H. S. Fawcett: The description that follows suggests that this disease may possibly be a form similar to the Bark Rot found in Java, or to Florida gummosis.

The disease is more serious on older trees than on younger ones, those under ten years of age being rarely affected. The principal symptom in the early age is the formation of scaly projections averaging 1 to 3 cm. in diameter, over the trunk and limbs. Underneath the scale is found a quantity of brownish gum. Later, the scale falls off, the gum is washed away by rain, and the wood is exposed. In this respect the disease is different from the scaly bark in California, in which case the scales are shallower, the deeper part of the bark being unaffected in the early stage. On younger, vigorous trees the lesions are fewer, and callus readily forms around the lesion, which eventually heals over. On older trees the lesions are numerous and healing is usually incomplete; the tree gradually declines and finally dies.

The disease is very serious in some orchards. Often over 50 percent of the trees are affected. Most growers ascribe it to the old age of the trees, and little if any attention is paid to it.

Decline. The cause of this disease is undetermined. The disease is believed to be the same as the so-called "yellow dragon disease" reported from Chowyang, Kwangtung. It appears to be due to improper water relations in the soil, and in some cases seems to be aggravated by lack of fertilizers.

Decline affects chiefly Citrus poonensis, and, to some extent, C. tankan and C. limon. The main symptoms are root rotting and leaf yellowing, followed by defoliation and the death of the tree. The root rotting begins at the tips of fine roots and advances toward the basal portions. Later, larger roots are also affected. The bark and the wood of the rotted root are easily separated. The bark often becomes shredded, and the wood generally becomes dark and water-soaked. The yellowing of the leaves does not follow a definite pattern. At the early stage, usually, the leaves on one or two branches begin to turn yellow. The yellowing of the leaf may start along the midrib and the main veins, while the interveinal areas remain green, a condition indicating nitrogen deficiency. In some cases the midrib and the main veins become suberized and crack longitudinally, showing the effect of boron deficiency. Sometimes the yellowing is restricted to one side of the leaf. In any case, the whole leaf eventually turns yellow and drops. The branches affected are usually on the same side of the tree as the rotted roots. The affected tree, in the advanced stage, generally has a number of defoliated branches, and it dies within a year from the time the first symptoms appear. The affected trees are, in most cases, under six years of age; trees over 12 years of age are seldom affected.

The disease is most serious in Chiangchow, Fukien, where it often kills 20 to 50 percent of the trees in various orchards. It is reported to be even more serious in Chowyang, Kwangtung. The disease is so de-

structive that it constitutes the limiting factor in the growing of C. poonensis in South China.

Convex Gum. A preliminary account of this disease has been published.[2] It is a new disease whose cause is not definitely known. The writer, however, believes it to be due to a virus. The disease affects only Citrus sinensis, variety Kushanchow Kan, in Foochow, Fukien. It causes considerable damage, especially to nursery trees and in young orchards.

The early symptoms are bark swelling and gum formation under the swollen bark of the trunk or limbs. The swollen areas average about 2.5 cm. in diameter. The gum is brownish in color and is formed in the wood 1 to 5 mm. beneath the cambium layer. Later, the gum breaks through the swollen bark, and a cankerlike lesion is formed. Two or more such lesions may coalesce and girdle the trunk or limbs of young trees, in which case the leaves turn yellow and the tree may soon die. The disease is particularly serious on young trees. On older trees the lesion generally heals over, and no serious damage is noticeable.

Greasy Spot. This is the same disease as that occurring in the United States. The disease is common in Fukien and Kiangsi. It is most serious on Citrus sinensis and C. grandis in Foochow, Fukien. C. poonensis and C. tankan are not so severely affected, and C. limon is practically free from the disease. It causes considerable damage to susceptible species in southern China and necessitates control measures which are yet to be found.

Sooty Mold (Pathogen: Meliola sp.). This mold, which usually grows on secretions of scale insects, is most serious on Citrus tangerina, C. grandis, and C. sinensis, and is mild on C. poonensis and C. tankan, in Fukien. It also occurs on C. sinensis in Kiangsi, but the damage done there is comparatively slight.

Blue Mold and Green Mold (Pathogens: Penicillium italicum and P. digitatum, respectively). Blue mold is common everywhere, but the green mold was seen on fruits of Citrus sinensis, C. grandis, C. poonensis, and others in Fukien only. In Chiangchow, Fukien, citrus fruits rotted by the green mold outnumbered those rotted by the blue mold, whereas in Pingshek, northern Kwangtung, where the Agricultural College of Lingnan University was located during the war, the writer failed to find a single case of green mold. Fukien and Kwangtung are separated by high mountain ranges. Whether or not this fact has any bearing on the distribution of the green mold is a matter for speculation.[3]

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[2] Lin, Kung-Hsiang. Convex gum, a new disease of citrus in China. Phytopathology 33: 394-397. 1943.

[3] Note by H. S. Fawcett: Blue mold sometimes predominates in certain orchards in California in cold, wet weather. At other times green mold may predominate. This is possibly because of seasonal differences.

Black Spot (Pathogen: Phoma citricarpa). Black spot is serious on fruits of Citrus poonensis in Chiangchow, Fukien. The disease was not seen on any other species of Citrus in the areas visited.

Brown Rot Gummosis (Pathogen: Phytophthora sp.). The only species of Citrus found to be affected with this disease was C. sinensis in Foochow, Fukien. The disease was serious in several orchards. In one orchard all the trees were killed. New seedlings were planted to replace the dead trees the next year, but were again completely killed. The disease was not widely distributed, however, in Fukien, and was not found in either Kiangsi or Szechuan.

Diplodia Gummosis (Pathogen: Diplodia sp.). This disease was found on Citrus tangerina in an orchard in Chengtu, Szechuan. More than 20 trees were seriously affected, and a number of them had been killed. As a contributing factor, it is probable that the trees had been injured by frost the previous winter, making the tissue susceptible to invasion by the Diplodia fungus commonly found associated with the disease.

The lesion involved a large area of the bark, extending several feet up and down the trunk or the limb in most cases. Over the surface of the lesion were found numerous fruit bodies (pycnidia) of the pathogen, which was isolated and inoculated into a number of limbs of several trees of Citrus tangerina. In the majority of cases, sunken lesions were produced. Such lesions enlarged rather rapidly and produced large quantities of brownish, sticky gum. No extensive survey was made of the disease, and the extent of the damage done in the district is consequently unknown.

Of Minor Importance

Magnesium Deficiency. This disorder is common on Citrus sinensis in Fukien and Kiangsi, but causes no serious damage. Only the leaf symptoms, as described by Fawcett,[4] were discernible. No affected trees were found to be deteriorating.

Melanose (Pathogen: Diaporthe citri). This disease occurs on Citrus sinensis in Kiangsi, Fukien, and in Szechuan. It also occurs on C. poonensis in Chiangchow, Fukien. The affected parts are fruits, leaves, and young twigs. So far as the observation goes, the disease is of little importance.

Oleocellosis. This is a rind spotting due to mere physiological

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[4] Fawcett, Howard S. Citrus diseases and their control 2d ed. 656 p. McGraw-Hill Book Company, Inc., New York, N.Y. 1936.

disturbances, as in California. It is common on orange and lemon fruits in Foochow and Chiangchow, Fukien, and also on orange in Chengtu, Szechuan.

Fruit Splitting. The splitting of fruits is thought to result from the excessive absorption of water by the fruits after heavy rain following a dry period. It is common on fruits of Citrus tangerina in Foochow and Chiangchow, Fukien, though other species of Citrus may also be affected.

Mesophyll Collapse. This disorder, which is of very little importance, is caused by physiological disturbances, as described by Fawcett.[5] It affects the leaf of Citrus sinensis in Fukien, Kiangsi, and Szechuan.

Loranthus Parasite. Citrus tangerina and C. poonensis in Fukien are often attacked by a species of Loranthus. In most cases the injury is slight, but in neglected and poorly kept orchards the trees may suffer considerably.

Lichens. Lichens of foliaceous type are very common on Citrus tangerina in Fukien and Kiangsi. They often completely cover the limbs and trunks of affected trees in Fukien. However, it remains to be determined to what degree the affected tree is injured.

Fusarium Fruit Rot (Pathogen: Fusarium sp.). This rot was found on a fruit of Citrus sinensis in Foochow, Fukien. The rot started from the interior and was not noticeable from the outside. When the fruit was cut open, the pulp was found to be discolored. The next day the exposed inner tissue became covered with scanty, white powdery mycelial growth of the fungus. The rot advanced gradually until the whole fruit was involved.

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AZALEA ROOT ROT IN MISSOURI

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Azalea root rot has been found in two greenhouses in the St. Louis area. In one it was first noticed in 1942 in plants grown in the South. In the second greenhouse it has been present for two years

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[5] See footnote 4.

and was first noticed in plants from the South. It is noteworthy that the disease was not present when homegrown cuttings were used. Ten percent of the plants were lost this year and there is evidence that the losses are increasing.

The disease first becomes manifest as a checking in the growth of the plant with or without chlorosis or necrosis of the leaves. In the more advanced stages the leaves on one or more branches assume a grey-green color, wilt and the branch dies. Ordinarily such plants die but sometimes the plants apparently may recover, particularly if not heavily watered. Plants may die while small or in any stage of development. Sometimes a plant in full bloom will gradually succumb. However, the disease is most destructive in plants about one year old.

The roots of the infected plants first become brown in small areas. With abundant moisture in the soil the disease spreads rather slowly. It may be checked in drier soils only to become active with increased moisture content of the peat. The repeated use of peat in which the azaleas are grown or in which the pots are plunged is apparently favorable to the increased destructiveness of the disease. It is also apparent that the coarser types of peat are less favorable to the spread of the organism than the finer grades. These facts indicate that high moisture content of the medium about the roots is favorable to the development of the pathogen.

The xylem tissues of the lower stem assume a yellowish brown color which is most pronounced in the more advanced stages of the disease. In advanced stages of infection the cortex and cambium of the stems become necrotic and discolored to a height of one inch or more above the soil level. The fibrous roots undergo destruction of the cortex, and the latter is easily detached from the stele.

Isolations from infected root and stem tissues yielded Phytophthora cinnamomi Rands. The fungus was obtained directly from the tissues in plate isolations, and indirectly by inserting small pieces of azalea tissues into apple fruits to a depth of 2-3 mm. The wounds were covered with petrolatum. After four to five days a firm brown circular zone of infection centered on the incision developed. Transfers of bits of the discolored subcuticular apple tissue from the marginal region of infection zones yielded pure cultures of Phytophthora cinnamomi. This method of isolation is useful for isolation of the fungus from tissues which are contaminated with soil or other bacteria and fungi.

In culture the isolates are characterized by their profuse development of clustered, irregular, poorly differentiated chlamydospores or vesicular bodies, and by their failure to develop sporangia or oogonia. On corn meal agar the isolates grew at 30° C., but were inhibited at 35° C. They may be regarded as typical of Phytophthora cinnamomi.

The occurrence of the fungus on azalea in the St. Louis area constitutes a new record of the geographic distribution of Phytophthora cinnamomi, but the species has previously been noted as a parasite of azalea in other regions.

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SPOT ANTHRACNOSES IN THE UNITED STATES AND SOME ISLAND POSSESSIONS

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The 12 spot anthracnoses[1] recorded in North America in 1936 (cf. 12, tab. 1) were all found in the United States and Puerto Rico. By 1939 the number had increased to 18 for the United States, Puerto Rico and Guam (14). Guam was included in this instance because of the discovery in 1937 of stem and foliage scab of sweetpotato on that island possession (23). The list and pertinent map prepared in 1939 were not published. It is convenient to present them at this time, revised, however, to include the 5 additional spot anthracnoses recorded in the United States, the two islands named, and also Hawaii, up to 1942. The Territory of Hawaii has been added at this time, particularly because of the report (9) of poinsettia scab in Honolulu. The distribution of all 23 diseases is based on records available as of June 1946. With Elsinoë batatas, the supposed (23) perfect stage of Sphaceloma batatas Saw., twelve of the pathogens of this group of diseases were described since 1936. In the list these particular organisms are followed by the citation to the original description.

Plantain scab has now been found in Minnesota and Oklahoma (7); otherwise the map is up to date for the diseases represented.

Additional spot anthracnoses or new suscepts of them now known in continental United States, also Puerto Rico in one instance (4), would practically double the above list. In this case the plants affected would be chiefly ornamentals including shade trees and edible fruits and the known distribution mostly in the southeastern (1,4,15, 24) and Pacific coast states (5, 6, 10, 20, 21). An exception is willow gray scab reported from Rhode Island, New York and Virginia (5), besides Washington (10), Oregon (20), and California (5). From a preliminary study specimens of elm (Ulmus sp.) leaves from Pennsylvania submitted by Dr. Alma M. Waterman appear to be affected by a spot anthracnose as do those of privet from Connecticut received indirectly from the same source. To the spot anthracnoses reported from Louisiana by Arruda and Edgerton (1), should be added one of oleander discovered in that state in 1943 by Dr. A. G. Plakidas, who contributed specimens (also see 25, p. 57).

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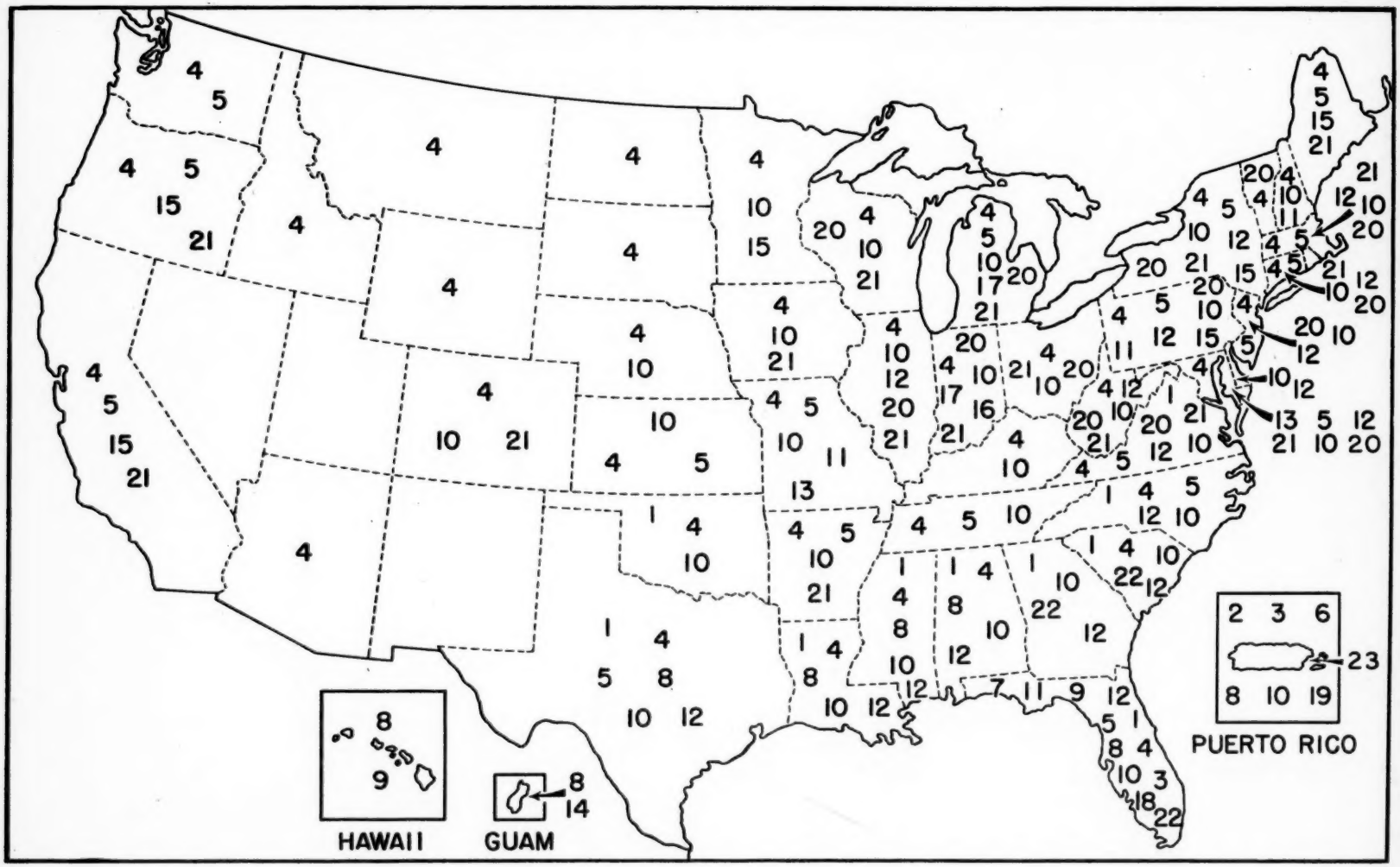
1 Specific term recently proposed (11) for collective reference to diseases caused by Elsinoë and Sphaceloma (16).


HAWAII
GUAM
PUERTO RICO

Disease	Genus and Species	Family	Pathogen
(1) Pecan anthracnose	Carya illinoensis	Juglandaceae	E. randii
(2) Iresine scab	Iresine argentata	Amarantaceae	E. amazonica
(3) Avocado scab	Persea americana	Lauraceae	S. perseae
(4) Bramble anthracnose	Rubus spp.	Rosaceae	E. veneta
(5) Rose anthracnose	Rosa spp.	"	S. rosarum
(6) Lima bean scab	Phaseolus limensis	Leguminosae	E. phaseoli
(7) Milk pea anthracnose	Galactia elliottii	"	S. floridensis (3, p. 159)
(8) Sour orange scab	Citrus spp.	Rutaceae	E. fawcetti
(9) Poinsettia scab	Euphorbia pulcherrima var. plenissima, more rarely E. poinsettiae	Euphorbiaceae	S. poinsettiae (22, p. 83)
(10) Grape anthracnose	Vitis spp.	Vitaceae	E. ampelina
(11) Virginia-creeper anthracnose	Parthenocissus	"	E. parthenocissi (17, p. 424)
(12) Violet scab	Viola spp.	Violaceae	S. violae
(13) Hercules club scab	Aralia spinosa	Araliaceae	S. araliae (8, p. 413)
(14) Sweetpotato stem and foliage scab	Ipomoea batatas	Convolvulaceae	E. batatas (23, p. 248)
(15) Ledum anthracnose	Ledum spp.	Ericaceae	E. ledi
(16) Lippia anthracnose	Lippia lanceolata	Verbenaceae	S. lippiae (2, p. 655)
(17) Mint anthracnose	Mentha spp.	Labiatae	S. menthae (8, p. 414)
(18) Indian mulberry anthracnose	Morinda spp.	Rubiaceae	S. morindae (3, p. 166)
(19) Randia scab	Randia spp.	"	E. puertoricensis (18, p. 65)
(20) Plantain scab	Plantago spp.	Plantaginaceae	S. plantaginis (19, p. 225)
(21) Snowberry anthracnose	Symphoricarpus albus var. laevigatus	Caprifoliaceae	S. symphoricarpi
(22) Goldenrod scab	Solidago spp.	Compositae	E. solidaginis
(23) Cordia scab	Cordia sp.	Boraginaceae	E. mayaguensis (3, p. 165)

On facing page:

Fig. 1. Distribution of the 23 spot anthracnoses that by 1942 had been recorded in the United States, Puerto Rico, Guam and Hawaii. Numbers correspond to those of the diseases in the list above.

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DIVISION OF MYCOLOGY AND DISEASE SURVEY, BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING AND INSTITUTO BICLOGICO, SÃO PAULO, BRAZIL.

CELERY MOSAIC IN THE EVERGLADES

G. R. Townsend

Celery has been grown on the mucklands of Palm Beach County, Florida, since 1927 or 1928. When the writer came to the Everglades in 1932, neither the acreage of celery nor the amount of mosaic in the crop were large. At that time only the southern celery mosaic of Wellman was recognized, but as the crop has assumed greater importance, the amount of mosaic and the number of apparent types have also increased. In addition to the brilliant southern celery mosaic, there now can be recognized a type characterized by a milder chlorosis and thin, downward rolling leaves, and a filiform leaf type. Possibly other forms or combinations of these are also involved in the mosaic complex on celery in this area.

Mosaic did not assume critical importance until about 1938 when heavy losses were noted in some of the older fields. In 1939 a loss of 80 percent of the crop was sustained in an old weedy field, while in the same stock of plants on new land where weeds were not common, there was no loss. The association of weeds with the celery seed bed areas or in the fields clearly has been related to severe outbreaks of mosaic in recent weeks. Although many species of weeds are suspected virus carriers, the outstanding weed host is Commelina longicaulis (C. nudiflora). This weed seldom is encountered on the newly cleared muck lands in the first year and in some cases it has not appeared after two or three years. On such farms the incidence of mosaic has been negligible. However, Commelina eventually establishes itself on all mucklands and celery mosaic follows. The weed easily propagates vegetatively and usually shows symptoms of mosaic infection, hence it is an excellent reservoir and agent for dissemination for the virus. Aphids, of course are the vectors that carry the virus from infected weeds to the celery.

The history of the development of celery mosaic has been traced briefly, showing the apparent relation of weeds, particularly Commelina, to the occurrence of the disease, but history may be turned back as in the case of one farm where celery has been grown successively for fifteen years. The disease increased so much between 1938 and 1943 that very heavy losses were encountered and it appeared that celery could not be grown if mosaic were not controlled. A program of weed control around the seed bed area and in the fields was instituted in 1944 and in each succeeding year has been extended and intensified. This program has been aided immensely by the use of 2,4-D sprays in the last two years. It has been a great satisfaction this year to find that this farm growing 200 acres of celery has lost less than 1 percent of the crop to mosaic. The only loss which has occurred on the farm was in one of the outside fields bordering a canal bank where some Commelina still grows. Contrasting with this situation mosaic has caused

nearly 100 percent infection on nearby weedy farms, and the losses from the disease are currently amounting to as much as 300 crates per acre on at least one of these farms.

The preceding remarks are not meant to belittle the role that the new insecticides have played in aphis control. Benzene hexachloride and the emulsified DDT concentrates have been found very useful. However, since even one aphid can transmit the virus, it would be very difficult to control mosaic by controlling the vectors alone.

BOX 505
BELLE GLADE, FLORIDA

ASSOCIATION OF SPLIT HEART OR DOUBLES WITH CRACK-STEM OF CELERY

Roy Bardin

Celery harvested for market in the Salinas Valley during the fall of 1945 and January of 1946 was frequently observed to show a split heart or double condition. Heavy corking of the adaxial portion of the petiole bases was invariably noted on such plants and appeared to be associated with an early failure of the main shoot apex. Lateral or adventitious buds, however, allowed a resumption of growth to take place, in which case usually two shoot apices took dominance over the others to form the so-called double or split heart plant. Upon close examination transverse scarring was found to be associated with the adaxial corking and usually to ascend the petioles for a distance of several inches.

Further investigations during the fall and winter of 1946 indicated that the condition described above may be associated with certain districts. On light sandy soil over 90 percent of the stalks in one planting showed these symptoms. In this same district, however, symptoms were often obscure and at harvest time (December, 1946) many plants did not clearly display a failure of the initial shoot apices.

In an area where the incidence of split heart did not exceed 1 percent, a few plants were gathered showing abaxial crack-stem associated with adaxial transverse corkiness. Some of these specimens did not show failure of the main shoot apex, but adaxial scarring was traced to petioles very near the growing point.

It is believed that boron deficiency may be responsible for the abaxial crack-stem since the specimens clearly fit the description for this condition and may possibly be the cause of the adaxial corking and split heart symptoms. Tests are now underway to determine if

the onset of these symptoms may be prevented by the application of boron.

It is interesting to note that although sugar beets have been grown in the area for over 40 years boron deficiency has been suspected but never demonstrated or corrected to the knowledge of this reporter.

MONTEREY COUNTY DEPARTMENT OF AGRICULTURE
SALINAS, CALIFORNIA

†SPREAD OF TOBACCO BLACK SHANK

T. E. Smith

Spread of Phytophthora by wind-borne inoculum is a recognized means of dispersal. Observations of such spread on tobacco have been lacking even though the fungus was known to fruit on leaves of field grown plants during rainy weather. As pointed out by Vaughn (PDR 27: 643-645, 1943) and others, tobacco black shank was found often in fields where the possibility of inoculum transport by surface water, contaminated soil, or other known methods failed to explain its occurrence. Secondary spread by wind-borne inoculum within the same field was reported earlier (PDR 28: 159, 1944). Evidence of local spread by air into a black-shank free field is reported at this time.

A single leaf lesion typical of Phytophthora was collected 18 inches above the soil on July 9, 1946, from one of the experimental fields on the Station Farm at Oxford, North Carolina. Microscopic examination revealed Phytophthora hyphae and sporangia. It is of interest that the collection was made following several days of rainy weather. The fungus was isolated and inoculated into tobacco cuttings with positive results. The field from which the collection came was free of soil-borne inoculum as shown by the absence throughout the season of diseased plants due to root or stalk infection. Black shank had occurred one-half mile away ten days earlier on a privately operated farm. There had been no exchange of farm machinery or tobacco seedlings between farms and because of the local terrain surface water could not have been concerned.

COOPERATIVE INVESTIGATIONS OF THE BUREAU OF PLANT INDUSTRY, SOILS AND AGRICULTURAL ENGINEERING, AGRICULTURAL RESEARCH ADMINISTRATION, U. S. DEPARTMENT OF AGRICULTURE, THE N. C. AGRICULTURAL EXPERIMENT STATION AND DEPARTMENT OF AGRICULTURE

REPORTS ON TOBACCO BLUE MOLD

These reports are transmitted to the Survey by S. A. Wingard, Chairman of the Tobacco Blue Mold Control Committee.

BLUE MOLD IN GEORGIA

By John G. Gaines

January 29 -- First 1947 symptoms of tobacco blue mold (Peronospora tabacina) were observed in two widely separated Georgia plant beds January 28. One of these beds, in a new location, was in Ware County, 65 miles from the other (old bed) in Cook County. Only a few plants were slightly affected at the time and no damage had been done in either bed. The largest plants in these beds were the size of a 50-cent piece, but most of them were much smaller. The majority of Georgia plants are still in the "square" stage. Some growers have already started spraying and dusting with Fermate.

November and December were unusually dry and plant beds sown in early December were too dry to permit germination before the first of January. The majority of Georgia beds were sown the last week in December and the week following. Weather conditions have been ideal for mold development throughout January. The frequent showers and almost continous cloudy warm weather were also favorable for quick germination of tobacco seed. Most growers report excellent stands of plants.

February 15 -- Blue mold developed within the past ten days in many scattered tobacco beds throughout the main part of the Georgia belt. In nearly all affected beds (new and old alike), symptoms are confined to plants in small patches, usually only one patch to the bed. Plants are small due to recent cold weather. Growers generally have already started spraying and dusting with Fermate. A Fermate shortage threatens due to inability of the manufacturer to fill orders. However, enough Fermate is already in the hands of the majority of growers to meet their 1947 needs.

Blue mold was first observed in Decatur County, in the northern part of the cigar-wrapper area, February 13. This is the earliest disease observation ever made in this part of the cigar area. Plants here are smaller than in the flue-cured section.

Below freezing temperatures were recorded at Tifton during 8 consecutive days from February 5 to 12, inclusive. During this period the average maximum daily temperature was 50 degrees (F) and the average minimum 24 degrees. The lowest maximum for any one day was 37 and the lowest minimum 21. During two nights the ground froze under the covers of unprotected beds in exposed places, and here plant loss probably exceeded 25 percent. Some few beds are being resown. Many growers

covered their beds with extra cloth or pine needles and these beds show no cold damage. Probably 15 percent of the Georgia plants were killed by cold. Initial mold symptoms developed at the close of the cold wave in both protected and unprotected beds, the disease being observed on badly frostbitten plants within 24 hours after freezing temperatures subsided. Cold weather following mold appearance is not unusual in Georgia. -- GEORGIA COASTAL PLAIN EXPERIMENT STATION, TIFTON, GEORGIA.

BLUE MOLD IN FLORIDA

By W. B. Tisdale

January 30 -- First specimens of tobacco seedlings showing blue mold were brought to the station this morning. The seedlings were in advanced 4-leaf stage, probably smaller than average for this area.

The temperature has been favorable all winter for development of blue mold. Although rainfall has been light, the beds have been watered and heavy fogs have been general.

To date, few or none of the farmers have used any treatment, but many farmers plan to dust or spray with Fermate.

February 10 -- Blue mold was found to have spread from primary infected beds to new land beds in some cases. Size of plants in infected beds vary from four-leaf stage to 1 1/2 inches high. Practically all plants in a few beds infected, many killed. Few farmers have started any control measures. Further immediate spread probably will be checked by low temperatures.

Severe cold damage on 5th and 6th mostly to large plants and in beds covered with old cloth improperly placed. -- AGRICULTURAL EXPERIMENT STATION, GAINESVILLE, FLORIDA.

BRIEF NOTES ON PLANT DISEASES

BOTRYTIS CANKER ON SNAPDRAGON IN MARYLAND

By R. A. Jehle

A severe infection of Botrytis canker caused by Botrytis cinerea was found in a greenhouse at Towson, Maryland. One or more cankers were found on almost every plant. Where the stems were girdled the portion above the canker wilted and was soon killed. Approximately 50% of the plants in the greenhouse were infected. Spraying with Fermate was suggested as a control measure. -- UNIVERSITY OF MARYLAND, COLLEGE PARK, JANUARY 23.

CHECK LIST REVISION

Freeman Weiss

ABUTILON (MALVACEAE) Revised from PDR 24: 243-244. 1940.

ABUTILON INCANUM (Link) Sweet, INDIAN MALLOW (1). Perennial of sandy plains in Tex. to Ariz. A. THEOPHRASTII Medic., VELVET LEAF (2). Annual of southern Asia, widely naturalized in waste ground near cities throughout the U.S. Both spp. furnish food for wildlife.

Alternaria sp. (? abutilonis (Speg.) Schwarze), leaf spot. Tex. (1,2); Ill., Ind., N.J., N.Y., W.Va. (2)
Cercospora abutilonis Tehon & Daniels, leaf spot. Ill. (2). C. althaeina Sacc., Tex. (1, 2); Kans. (2)
Cladosporium herbarum Pers. ex Fr., leaf spot (secondary). N.Y. (2)
Colletotrichum malvarum (A.Braun & Casp.) Southworth, leaf spot. Iowa (2)
Heterodera marioni (Cornu) Goodey, root knot. ? Fla. (2)
Macrophomina phaseoli (Maub.) Ashby, stem rot. Ill. (2)
Phyllosticta althaeina Sacc., leaf spot. Tex. (1,2); Kans. (2)
Phymatotrichum omnivorum (Shear) Dug., root rot. Tex. (1,2)
Puccinia heterospora Berk. &Curt. (III), rust. Ariz., Tex. (1,2); Kans., Md., Mo., Nebr. (2)

Mosaic -- unidentified virus. Iowa, Kans., Md., N.Y. (2)

ABUTILON spp. (cultivated), ABUTILON, (flowering-maple) especially A. STRIATUM Dicks. clon THOMPSONII Veitch, VARIEGATED A. (1); other spp. (2). Shrubby perennials mostly of Central or South American origin, grown for ornament as house plants in the North and in the open in warm regions.

Asterina diplocarpa Cke., black mildew. P.R. (2)
Cercospora brachypoda Speg., leaf spot. P.R. (2)
Heterodera marioni (Cornu) Goodey, rootknot. Ala. (2)
Puccinia heterospora Berk. & Curt. (III), rust. Fla. to Ariz.; Hawaii, P.R., West Indies (2)
P. malvacearum Bert. (III), rust. Hawaii. On A. molle Sweet
Verticillium albo-atrum Reinke & Berth., wilt. N.J. (2)

Mosaic, infectious chlorosis -- virus (Marmor abutilon Holmes, Abutilon virus 1 K.M.Sm.). Universal in (1) and related variegated forms.

ALTHAEA (MALVACEAE)

ALTHAEA ROSEA Cav., HOLLYHOCK (1). Biennial or semiperennial of China, cult. for ornament throughout the U.S., often escaped and locally naturalized. Other spp., as A. CANNABINA L. (2) and A. FICIFOLIA Cav., (3), are also grown for ornament.

Agrobacterium rhizogenes (Riker et al.) Conn, hairy root. Wis. (1)

Alternaria spp. (probably chiefly A. tenuis Nees ex Cda.), secondary leaf spot. Conn. to N.Car., Nebr., and Minn. (1)

Ascochyta althaeina Sacc. & Bizz., leaf spot. Ind., Md., N.J., N.Y., Pa. W.Va. (1); N.Y. (2). A. parasita Fautr., Conn., Del., Md., W.Va. (1)

Bacterium solanacearum E.F.Sm., bacterial wilt. N.Y., ?W.Va. (1)

Cercospora althaeina Sacc., leaf spot. Eastern and Central States to Ala., Tex. and S.Dak. (1)

C. kellermanii Bub., leaf spot. Ind., Minn., Mo., Ohio., Md.?, N.J. (1)

Colletotrichum malvarum (A.Braun & Casp.) Southworth, anthracnose, seedling blight. N.Y. to Miss., Tex. and Iowa (1)

Endophyllum tuberculatum Ell. & Kell. (III), rust. Colo., Kans., Nebr., Okla. (1)

Erysiphe cichoracearum DC. (conidial stage), powdery mildew. Calif. (1,2), Miss. (1). E. polygoni DC., Iowa (1)

Heterodera marioni (Cornu) Goodey, root knot. Fla., Kans., Miss., Okla., Tex. (1)

Myrothecium roridum Tode ex Fr., leaf spot. Md. (1)

Nectria cinnabarina Tode ex Fr., branch canker. Okla. (sp.)

Phyllosticta althaeina Sacc., leaf spot, stem canker. Ala., N.J., N.Y., Ohio, Pa., W.Va. (1)

Phymatotrichum omnivorum (Shear) Dug., root rot. Ariz., Tex. (1)

Physalospora obtusa (Schw.) Cke., on dead stems. Ala. (1)

Phytophthora megasperma Drechs., crown rot. Md., Va. (1)

Pratylenchus pratensis (De Man) Filip., root nematode. Tex. (1)

Puccinia heterospora Berk. & Curt. (III), rust. Calif., Kans., Tex., P.R., Virgin Is. (1)

P. lobata Berk. & Curt. (III), rust. Ariz., N.Mex., Tex. (1)

P. malvacearum Bert. (III), rust. General (1); Calif., Colo., N.Y., Ore. (3)

P. schedonnardi Kell. & Swing. (O,I), rust. Kans., Miss., Nebr., N.J.?, N.Dak. (1)

P. sherardiana Koern. (O,III), rust. Calif. (1)

Rhizoctonia microsclerotia Matz, web blight. Tex., P.R. (1). Mycelial stage of Pellicularia filamentosa (Pat.) Rogers

Sclerotinia sclerotiorum (Lib.) DBy., crown rot. Mont., N.J. (1)

Sclerotium rolfsii Sacc., southern blight. Ark. (1)

Septoria malvicola Ell. & G. Mart. (S. fairmanii Ell. & Ev.) leaf spot. Mich., Minn., Ohio, Okla., N.Y., Vt. Wis.

Althaea cont.
Mosaic -- unidentified virus. P.R. (1)

ANODA (MALVACEAE)

ANODA HASTATA Cav. (1) and A. LAVATEROIDES Medic (2). Annuals of Mexico and S.America grown for ornament, the latter also occurring naturally in Tex. to Ariz., a food plant for wildlife.

Oidium erysiphoides Fr., powdery mildew. N.Mex. (1)
Puccinia sp. (? heterospora Berk. & Curt.), rust. Tex. (2)

CALLIRHOË (MALVACEAE)

CALLIRHOË ALCAEOIDES (Michx.) A. Gray (1), C. DIGITATA Nutt. (2), and C. INVOLUCRATA (Torr. & A.Gray) A.Gray (3), POPPY-MALLOW. Low perennial herbs of sandy plains in the Southern and Central States, sometimes grown for ornament.

Cercospora althaeina Sacc., leaf spot. Kans., Nebr. (3). Var. praecincta J.J.Davis, Ill., Wis. (on C. triangulata).
Endophyllum tuberculatum Ell. & Kell. (III), rust. Kans. (1). Ind., Kans., Nebr., Okla., Tex. (3)
Puccinia interveniens (Pk.) Bethel (O,I), rust. Nebr. (1), Tex. (2), N.Y. (sp.). II and III on Stipa spp.
P. schedonnardi Kell. & Swing. (O,I), rust. Kans., Nebr. (1); Okla. (2); Colo., Kans., Nebr., Okla., Tex., Utah (3). II and III on various grasses.
Synchytrium australe Speg., on leaves. Kans.,Tex. (3)
Verticillium albo-atrum Reinke & Berth., wilt. N.Y. (on C. papaver).

GOSSYPIUM (MALVACEAE)

GOSSYPIUM HIRSUTUM L., UPLAND COTTON, cultivated cotton in the broad sense (1). Annual or short-lived perennial of tropical America, principal source of cultivated vars. of cotton, but much influenced by hybridization with other spp. as G. BARBADENSE L., SEA-ISLAND COTTON (2), G. HERBACEUM L., LEVANT C. (3), and others. Records specifically applicable to the latter 2 spp. are separately indicated when available, but in general all the records pertain to (1). The "Cotton Belt" typically extends from and includes N.Car. to Ga., Tex., and Okla.; but in addition Va., Fla., Mo., N.Mex., Ariz., and Calif. produce commercial quantities.

(Aecidium gossypii Ell. & Ev.): Puccinia stakmanii

Gossypium cont.

Agrobacterium tumefaciens (E.F.Sm. & Town.) Conn, crown gall. Ariz., Okla., Tex.

Alternaria spp., leaf blight (perhaps secondary, as a sequel to potassium deficiency or bacterial spot), boll rot, lint stain, seed mold, ? seedling blight. Eastern Cotton States to Ariz. and Okla. (1,2,3). A. gossypii of auths. (? A.g. (Jacz.) Nisikado et al) has no nomenclatural standing, probably is A. tenuis Nees ex Cda., as is also A. gossypina (Thuem.) Hopkins. A. macrospora Zimm. (A. longipedicellata (Reichert) Snowden) has not been recorded in the U.S. but is known from Trinidad.

Aphelenchoides parietinus (Bast.) Steiner, also Aphelenchus avenae Bast., nematodes associated with seedling stem lesions (soreshin) but not a primary factor. Reported from Ark. and S.Car., doubtless general.

Arthrobotrys superba Cda., associated with fiber deterioration. Canal Zone.

Ascochyta gossypii Syd., leaf blight, boll rot. Va. to Ala., La., and Okla.

Aspergillus spp., boll rot, lint stain, fiber deterioration. A. niger v. Tiegh. as a cause of boll rot (black mold) is reported especially in the Southwest from Tex. and Okla. to Calif. but is cosmopolitan as associated with fiber deterioration. Additional spp. reported on fiber include A. flavus Lk. ex Fr., A. fumigatus Fres., A. nidulans (Eidam) Wint., A. ochraceus Wilhelm, A. versicolor (Vuill.) Tiraboschi, and others.

(Bacterium malvacearum E.F.Sm.): Xanthomonas m.

(Botryodiplodia theobromae Pat.): Physalospora rhodina

Botryosphaeria ribis (Tode ex Fr.) Gross.& Dug., boll rot, also on stems. Ala., Ga., La., Miss., S.Car., Tex. (1,3). Includes reports as Dothiorella sp., D. major Ell. & Ev., B. berengeriana De Not., and B. fuliginosa (Moug. & Nestl.) Ell. & Ev. See also Physalospora.

Brachysporium sp., boll rot, seedling blight. Okla., Tex.; fiber deterioration, Fla. See also Curvularia and Helminthosporium.

Cephalosporium acremonium Cda. ex Fres., fiber deterioration. Fla.

Cercospora althaeina Sacc., leaf spot. Ill., N.&S.Car., Tex.

(C. gossypina Cke.): Mycosphaerella gossypina

(Cerotelium desmium (Berk. & Br.) Arth.): Phakopsora desmium

Chaetomium spp., fiber deterioration. C. globosum G. Kunze ex Fr. is commonly cited in this connection; likewise C. elatum G. Kunze ex Fr., C. funicola Cke., and numerous others.

Choanephora cucurbitarum (Berk. & Rav.) Thaxt., boll rot. N.Car., Tex.

Cladosporium herbarum Pers. ex Fr., secondary boll rot and leaf spot, seed mold, fiber deterioration. Cosmopolitan.

(Colletotrichum gossypii Southworth): Glomerella gossypii.

Cunninghamella spp. (C. echinulata Thaxt., C. elegans Lendner and

Gossypium cont.

others), fiber deterioration. Fla., Canal Zone.

Curvularia spp. (C. lunata (Wakk.) Boed., C. maculans (Bancroft) Boed., and others), fiber deterioration. Fla., Canal Zone.

(Diplodia gossypina Cke., D. natalensis Pole-Evans): Physalospora rhodina.

Diplodia spp., boll rot, fiber deterioration. Ariz., Ark., Fla., Ga., S.Car., Tex. In part the preceding sp., and probably others.

Diplodiella cowdellii (Berk. & Br.) Sacc., fiber deterioration. Fla.

Fusarium moniliforme Sheldon, boll rot, seed mold, dry root rot. General in humid parts of the Cotton Belt, usually as a secondary invader.

F. oxysporum Schlecht. f. vasinfectum (Atk.) Snyder & Hansen, Fusarium wilt. General in the Cotton Belt, rare in the Southwest (1,2,3).

Fusarium spp. (other), boll rot, pink mold, seedling blight. General, in the Eastern Cotton Belt, occasional in the Southwest (1,3). Besides F. moniliforme the following are reported: F. equiseti (Cda.) Sacc., F. scirpi Lambotte & Fautr. and its var. acuminatum (Ell. & Ev.) Wr., F. semitectum Berk. & Rav. (the latter 4 = F. roseum Lk. in the sense of Snyder & Hansen), and F. solani (Mart.) Appel & Wr.

Glomerella gossypii Edg., anthracnose, pink boll rot, seedling blight. General in the Southeastern and Gulf States to eastern Tex. and Okla., and in Ky., Tenn. and Mo.; also Hawaii, P.R. and Guam (1,2,3)

Helminthosporium sp., boll rot, seedling blight. Okla., Tex.

H. gossypii Tucker, leaf and boll spot. P.R.; black stem, Tex.

Hendersonia sarmentorum West., and H. sp., fiber deterioration. Fla.

Heterodera marioni (Cornu) Goodey, root knot. General from Va. to Fla., Tex. and Mo.; also Ariz. and Calif. (1,2,3)

Leptosphaeria spp., fiber deterioration. Fla.

Macrophomina phaseoli (Maub.) Ashby, stem blight. Va. to Ga., Tex., and Okla.

(Macrosporium gossypinum Thuem.): Alternaria tenuis.

M. nigricantium Atk. See Pleospora

Memnoniella echinata (Rivolta) L.D.Galloway, fiber deterioration. Fla., Md., Tex., Canal Zone

Monilia crassa Shear & Dodge and M. sitophila (Mont.) Sacc. (=Neurospora c. Shear & Dodge and N. s. Shear & Dodge), fiber deterioration. Canal Zone.

Mucor spp., fiber deterioration. Cosmopolitan.

Mycosphaerella areola Ehrlich & Wolf, areolate mildew, frosty blight. Va. to Fla., Tex., and Okla.; Calif., Ill., P.R. (1, 2). The conidial stage is commonly known as Ramularia areola Atk. but was first described as Cercosporella gossypii Speg.

Gossypium cont.

M. gossypina (Atk.) Earle (Cercospora gossypina Cke.), leaf spot. Va. to Fla., Tex., and Okla.; Ill., P.R. (1,2,3).

Myrothecium verrucaria Ditmar ex Fr. (Metarrhizium glutinosum Pope), fiber deterioration. Fla., Md.

Nectria cinnabarina Tode ex Fr., on stems. Ga., Tex.

Nematospora coryli Pegl., internal boll disease. Calif. N. gossypii Ashby & Nowell, associated with a similar disease, is reported on (2) in P.R. and elsewhere in the West Indies.

Neocosmospora vasinfecta E.F.Sm., on dead stems. Ala., Ark., N.& S.Car., Tex., and other Southern States but many reports under this name refer to Fusarium vasinfectum Atk., an unrelated organism.

Nigrospora sphaerica (Sacc.) Mason, seed mold, fiber deterioration. Canal Zone.

Olpitrichum carpophilum Atk. See Rhinotrichum

Ozonium texanum Neal & Wester, on dead roots and stems. Tex.

Pellicularia filamentosa (Pat.) Rogers (Rhizoctonia solani Kuehn), seedling blight, leaf blight. Reported in this stage in S.Car., but in Rhizoctonia stage is general.

Penicillium spp., secondary boll rot, fiber deterioration. Cosmopolitan.

Pestalotia spp. (P. gracilis Kleb. and others), fiber deterioration. Fla., Canal Zone.

Pestalozziella gossypina Atk., secondary boll rot. Ala., Okla., Tex.

Phakopsora desmium (Berk. & Br.) Cumm. (II,III). rust. Fla., P.R. (1,2). O and I unknown.

Phlyctaena gossypii Sacc., on stems. Ala., S.Car.

Phoma sp., seedling blight. Miss., Tex.

P. gossypii Sacc., on stems. Ala., Ga., Miss., S.Car., Tex.

Phyllosticta gossypina Ell. & G.Mart., leaf spot. Ala., La., Miss., N.&S.Car., Tex., P.R. (1,3)

P. malkoffii Bub., leaf spot. Tex., P.R. (1,2)

Phymatotrichum omnivorum (Shear) Dug., root rot. Ariz., Ark., Calif., N.Mex., Okla., Tex. (1,2,3)

Physalospora rhodina (Berk.&Curt.) Cke. (P. gossypina N.E.Stevens, Diplodia gossypina Cke.), Diplodia boll rot, seedling blight; also associated with fiber deterioration. Va. to Fla., Tex. and Okla., especially the lower Mississippi Valley; also Ill., Md., P.R. (1,3). P. abdita (Berk. & Curt.) N.E.Stevens, reported on cotton stems in Fla., La. and Tex., may also be connected with Diplodia spp. causing boll rot.

Phytophthora parasitica Dast., boll rot. P.R., ? Fla. (1,2)

Pleospora nigricantium Atk. (? P. herbarum (Pers. ex Fr.) Rab.), on leaves affected with "black rust," in association with Macrosporium nigricantium Atk. The latter is a Stemphylium (? S. botryosum Wallr.); it develops as a sequel to "rust" (mineral deficiency) and occurs throughout the Cotton Belt (1,3).

Gossypium cont.

Pratylenchus pratensis (DeMan) Filip., root browning and necrosis. Ga. N.&S.Car.

Puccinia stakmanii Presley (O,I), rust. Ariz., Ark., N.Mex., Okla., Tex. (1): Ariz., Tex. (2,3). II and III on Bouteloua spp.

Pullularia pullulans (DBy.) Berkhout, fiber deterioration. Cosmopolitan.

Pythium spp., damping off. Gulf States, N.Car., Tenn. P. debaryanum Hesse reported in Ala., Miss., N.Car., Tex.; P. ultimum Trow in N.&S.Car.

Rhinotrichum macrosporum Farl., secondary boll rot. Southeastern and Gulf States. (1,3). Also reported as Oidiotrichum macrosporum (Farl.) Sumstine (O. carpophilum Atk.), and Oidium macrosporum (Farl.) Linder.

R. tenellum Berk. & Curt., secondary boll rot. Ala., Fla., La., S.Car. Reported also as Oidium tenellum (Berk. &Curt.) Linder.

Rhizoctonia solani Kuehn, damping off, sore-shin, leaf blight. General (1,2,3). See also Pellicularia filamentosa.

Rhizopus stolonifer (Ehr. ex Fr.) Lind (R. nigricans Ehr.) boll rot. Gulf States. Ariz., Calif., Okla.

Schizophyllum commune Fr., root and stem rot. (? secondary). Calif., La.

(Sclerotium bataticola Taub.): Macrophomina phaseoli

S. rolfsii Sacc., southern blight. Gulf States, Ariz., Okla.

Septoria gossypina Cke., on stems. Miss., S.Car. (1,3)

Stachybotrys atra Cda., fiber deterioration. Md., Canal Zone.

Stemphylium. See Pleospora.

Thielavia sp. (? basicola Zopf), fiber deterioration. Fla.

Thielaviopsis basicola (Berk. & Br.) Ferr., root rot. Ala., Ariz., Tex. (1,3)

Trichoderma viride Pers. ex Fr., secondary boll rot, seed mold, fiber deterioration. Cosmopolitan.

Trichothecium roseum Lk. ex Fr., secondary boll rot. seed mold. Ala., Calif., N.Mex., Tex.

Valsa gossypina Cke. (?V. decorticans Fr.), on stems. Ga., S. Car. (1,3). Also reported in the conidial stage as Cytospora sp. in Tex.

Verticillium albo-atrum Reink. & Berth., wilt. Occasional throughout the Cotton Belt, especially in Ariz., Calif., N.Mex. and Tex. (1,2,3). Reported as V. dahliae Kleb. in Miss.

Xanthomonas malvacearum (E.F.Sm.) Dowson, angular leaf spot, bacterial blight and boll rot, black arm. General (1,2,3).

Crazy-top (acromania) -- cause unknown, believed physiological associated with impervious soil and irregular moisture supply. Ariz., Calif. (1,2)

Crinkle-leaf -- physiological, attributed to calcium deficiency and manganese toxicity and is associated with acid soils. La.

Gossypium cont.

Mosaic -- in part nutritional (see "rust"), in part hereditary but non-infectious and presumed of genetic origin. Tex.

"Rust", potash hunger -- yellowing, browning, and premature shedding of foliage resulting from deficiency of potassium, sometimes also of magnesium. On light and depleted soils throughout the Cotton Belt, especially in dry years. Early references to "mosaic" and yellow leaf blight pertain to this; "black leaf rust" ensued when affected foliage was overgrown by secondary fungi.

Sand drown -- leaf reddening and premature defoliation resulting from magnesium deficiency. Especially in the Southeastern and mid-Southern States; also Ark. and Okla.

Stigmatomycosis -- internal boll rot, lint staining and boll shedding caused by certain bollfeeding insects (Dysdercus spp., Nezara viridula L., and others) together with fungi (Nematospora and others). Reported in Ariz. and prevalent in the West Indies.

GOSSYPIUM spp., other types used in breeding or sometimes cult.; shrubby perennials, as G. ARBOREUM L., ASIATIC TREE COTTON (1), G. MEXICANUM Todaro, MEXICAN C. (2), G. PERUVIANUM Cav., PERUVIAN C. (3); also G. THURBERI Todaro, ARIZONA WILD COTTON (4), a native shrub of s. Ariz. and Mexico, occasionally planted for ornament.

Diplodia theobromae (Pat.) Nowell, dieback. Tex. (4)

Phakopsora desmium (Berk. & Br.) Cummins (II,III), rust. Fla. (1,2,3)

Phymatotrichum omnivorum (Shear) Dug., root rot. Tex. (4)

Xanthomonas malvacearum (E.F.Sm.) Dowson, bacterial blight. Okla. (1,3): Ariz. (4)

HIBISCUS (MALVACEAE)

HIBISCUS ESCULENTUS L., OKRA. Annual of Old World tropics, cult. mostly in the South for edible pods.

Alternaria sp. (? A. tenuis Nees ex Cda.), leaf spot (secondary). Fla., Ohio, Pa., S.Car., Utah. Most of the reports of Macrosporium spp. on this host belong here.

Ascochyta abelmoschi Harter, pod spot. Ga., Md., N.J., N.Y., Pa.

Botrytis sp., pod rot. N.Y.

Cercospora hibisci Tracy & Earle, leaf spot. N.Car. to Fla. and Tex.; P.R. Reported also as C. althaeina Sacc., of which this is perhaps a synonym; reports of C. brachypoda Speg. may also belong here.

C. malayensis F.L.Stevens & Solheim, leaf spot. Va. to Fla., Tex. and Okla.

Hibiscus cont.

Choanephora cucurbitarum (Berk. & Rav.) Thaxt., blossom blight. Fla., Ga., Tex., P.R. C. conjuncta Couch is reported on fallen flowers in Ga.

Colletotrichum gloeosporicides Penz., pod spot. Fla.

Diaporthe arctii (Lasch) Nits., on stems. Ga.

Diplodia theobromae (Pat.) Nowell, on stems. Ala.

Erysiphe cichoracearum DC., powdery mildew. Conn., N.J., N.Car., Pa.

Fusarium sp. (usually reported as F. oxysporum Schlecht and sometimes as f. vasinfectum (Atk.) Snyder & Hansen), wilt. Conn. to Fla., Tex., and Ariz.

Heterodera marioni (Cornu) Goodey, root knot. General in Southern States, also Ariz., Kans., N.Mex., Hawaii

Macrophomina phaseoli (Maub.) Ashby, charcoal rot. Tex.

Phoma okra Cke., on stems. La., S.Car.

Phyllosticta hibiscina Ell. & Ev., leaf spot. Ala., Ill., N.J., N.Car., Okla.

Phymatotrichum omnivorum (Shear) Dug., root rot. Ariz., Tex.

Rhizoctonia solani Kuehn, damping off, root rot. Ala., Fla., Okla., Tex.

Sclerotinia sclerotiorum (Lib.) DBy., stem rot. Mass.

Sclerotium rolfsii Sacc., southern blight. Ala., Fla.

Thielaviopsis basicola (Berk. & Br.) Ferr., root rot. N.J.

Verticillium albo-atrum Reinke & Berth., wilt. Widespread, including Eastern, Southern, and Pacific States.

Ring spot -- virus (Marmor annularium McKinney, Nicotiana virus 12 K.M.Sm.). Ga., Va.

HIBISCUS PALUSTRIS (MOSCHEUTOS) L., ROSE-MALLOW (1). Robust perennial of marshy habitats ranging from Mass. to Fla. and Mo., principal source of garden mallows. Other spp., as H. GRANDIFLORUS Michx., H. LASIOCARPOS Cav. and others (2), wildlife food plants.

Agrobacterium tumefaciens (E.F.Sm. & Town.) Conn., crowngall. Miss. (1)

Ascochyta abelmoschi Harter, leaf spot. N.Y. (1); A. gossypii Syd., Ark., (2)

Cercospora kellermanii Bub., leaf spot. Ind. (1)

Colletotrichum hibisci Pollacci (? C. gloeosporioides Penz.), dieback. Tex.

Phyllosticta hibiscina Ell. & Ev., leaf spot. Conn., Fla., La., Md., N.J., N.Y.

Phymatotrichum omnivorum (Shear) Dug., root rot. Tex. (1)

Puccinia schedonnardi Kell. & Swing. (O,I), rust. Conn. to Ala., Tex., and Nebr. (1,2). II and III on Muhlenbergia, Sporobolus, and other grasses.

Hibiscus cont.
Rhabdospora hibiscicola (Schw.) Starb., on stems (1). Septoria sp., leaf spot. N.J. (1)

HIBISCUS SABDARIFFA L., ROSELLE. Annual or biennial of Old World tropics, grown in warm countries for edible fruits.

Botryosphaeria ribis (Tode ex Fr.) Gross. & Dug., dieback. Hawaii
Botrytis cinerea Pers. ex Fr., gray-mold blight. Md.
Cercospora hibisci Tracy & Earle, leaf spot. Tex.
Colletotrichum gloeosporioides Penz., anthracnose. Fla.
Fusarium sp., fruit rot, stem rot. Fla., P.R.
F. solani (Mart.) App. &Wr. f. radicicola (Wr.) Snyder & Hansen, root rot. Hawaii
Heterodera marioni (Cornu) Goodey, root knot. Tex., Hawaii
Microsphaera euphorbiae (Pk.) Berk. & Curt., powdery mildew. Ala., Fla., P.R.
Phymatotrichum omnivorum (Shear) Dug., root rot. Tex.
Phytophthora parasitica Dastur, stem rot. Tex., P.R.
Rhizoctonia solani Kuehn, damping off, root rot. Tex., P.R.
Sclerotium rolfsii Sacc., southern blight. Tex.

HIBISCUS spp. (arborescent), as H. mutabilis L., H. sinensis L., and H. syriacus L. See PDR 25: 262-263. 1941.

LAVATERA. See PDR 25: 322. 1941.

MALACHRA. See PDR 25: 366. 1941.

MALVA (MALVACEAE)

MALVA spp., MALLOW. (1) Garden spp. as M. MOSCHATA L., M. BOREALIS Wallm., M. PARVIFLORA L., and M. SYLVESTRIS L.; (2) non-cultivated spp. as M. ROTUNDIFOLIA L. Mostly biennial (some annual) herbs of Europe, some grown in gardens and locally escaped, others widely naturalized in the U.S.; wildlife food plants.

Agrobacterium tumefaciens (E.F.Sm. & Town.) Conn, crown gall. N.Y. (2)
Alternaria sp., leaf spot. Mich. (1), Ind., N.Y. (2)
Ascochyta althaeina Sacc. & Bizz., leaf spot. Md. (2)
Cercospora althaeina Sacc., leaf spot. N.J. to Miss. and Kans. (2)
C. malvarum Sacc., leaf spot. Ind., Kans., N.J. (2)
Erysiphe cichoracearum DC., powdery mildew. Calif. (1)

Malva cont.

Colletotrichum malvarum (A. Braun & Casp.) Southworth, leaf spot. N.Dak. (1): as C. magnusianum Bres., Wis. (2)

Phymatotrichum omnivorum (Shear) Dug., root rot. Tex. (1,2)

Puccinia heterospora Berk. & Curt. (III), rust. Kans., Tex. On M. sylvestris.

P. malvacearum Bert. (III), rust. Calif., Colo., Ore., W.Va. (1); general (2)

Rhizoctonia solani Kuehn, root rot. Wash. (2)

Septoria malvicola Ell. & G.Martin, leaf spot. Vt. to Mo. and N.Dak. (2)

Curly top -- virus (Chlorogenus eutetticola Holmes, Beta virus 1 K.M.Sm.). Calif. (1,2)

MALVASTRUM. See PDR 25: 392. 1941.

MALVAVISCUS. See PDR 25: 392. 1941.

MONTEZUMA. See PDR 25: 399. 1941.

PAVONIA. See PDR 25: 437. 1941.

SIDA (MALVACEAE)

SIDA spp. Annual or perennial herbs or shrubs, mostly tropical or extending into the Southern and Southwestern States; a few are occasionally grown for ornament, and several are food-plants of wildlife. Spp. represented here are S. ACUTA Burm. (1), S. HEDERACEA (Dougl.) Torr. (2), S. RHOMBIFOLIA L. (3), S. SPINOSA L. (4)

Asterina diplocarpa Cke. (A. sidicola Ryan), black mildew. P.R. (1)

Cercospora densissima Speg., leaf spot. P.R. (1). C. sidicola Ell. & Ev., La. (4)

Colletotrichum malvarum (A. Braun & Casp.) Southworth, leaf spot. Kans., Utah (4)

Heterodera marioni (Cornu) Goodey, root knot. Fla. (3); Ala. (4); Miss., Hawaii (spp.)

Irenopsis molleriana (Wint.) F. L. Stevens, black mildew. P.R.

Oidium erysiphoides Fr., powdery mildew. Virgin Is.

Phyllosticta spinosa Ell. & Kell., leaf spot. Kans. (4)

Phymatotrichum omnivorum (Shear) Dug., root rot. Tex. (2,3,4)

Sida cont.

Puccinia heterospora Berk. & Curt. (III), rust. Fla. to La., Mo., and Ind. (4); Ariz., Calif., Tex. (A. hastata St. Hil); Hawaii, P.R.; Virgin Is. (spp.)

P. lobata Berk. & Curt. (III), rust. Ariz., Calif., N.Mex., Tex., Utah (2)

P. malvacearum Bert. (III), rust. Hawaii

P. schedonnardi Kell. & Swing. (O,I), rust. N.Mex. (2)

Ramularia sidarum Petr. & Cif., leaf spot. Fla. (1)

Sclerotium rolfsii Sacc., southern blight. Fla. (3)

Mosaic -- virus (Marmor abutilon Holmes, Abutilon virus 1 K.M.Sm.) Fla. (3), P.R. (1,3)

SIDALCEA (MALVACEAE)

SIDALCEA spp., CHECKER-MALLOW. Perennial herbs of the Pacific and Rocky Mountain States, all bearing showy flowers and some introduced into cultivation, also food plants for wildlife. Spp. represented here are S. CANDIDA A.Gray (1), S. MALVAEFLORA (Moc. & Sesse) A.Gray (2), S. NEOMEXICANA A.Gray (3), S. OREGANA (Nutt.) A.Gray (4)

Endophyllum tuberculatum (Ell. & Kell.) Arth. & Fromme (III), rust. Colo. (1,2,3); Wyo. (2,3)

Leptosphaerulina sidalceae Zeller, on stems. Ore.

Mycosphaerella sp. (Sphaerella sidicola Ell. & Ev.), on leaves. Calif. (2), Utah (4)

Phoma sidalceae Fairman, on stems. N.Mex. (3)

Puccinia interveniens (Peck) Bethel (O,I), rust. Utah (1,3,4); Calif., Mont. (2); Colo., Wyo (3); Ida. (4); Ore., Wash. II and III on Stipa spp.

P. schedonnardi Kell. & Swing. (O,I), rust. Colo. (1). II and III on Muhlenbergia, Sporobolus, etc.

P. sherardiana Koern. (O,III), rust. Calif. (2,4); Nev. (2); Colo., Ore., Wash. (4); Ariz.

Ramularia sidalceae Ell. & Ev., leaf spot. Colo. (1,3)

SPHAERALCEA (MALVACEAE)

SPHAERALCEA spp., GLOBE-MALLOW. Mostly perennial herbs of plains and open woodlands in the Rocky Mountain and Southwestern States; showy-flowered and sometimes grown in gardens, also wildlife food plants. Spp. represented here are S. AMBIGUA A. Gray (1), S. ANGUSTIFOLIA (Cav.) G.Don (2), S. FENDLERI A. Gray (3), S. MUNROANA (Dougl.) Spach (4), S. RIVULARIS Torr. (5)

Sphaeralcea cont.

Erysiphe polygoni DC., powdery mildew. Ida. (5)

Puccinia interveniens (Pk.) Bethel (C,I), rust. Ida., Wash. (5)

P. schedonnardi Kell. & Swing. (O,I), rust. Ariz. (1); N.Mex. (2,4)

P. sherardiana Koern. (O,III), rust. Ariz., Calif., Colo., Nev., N.Mex., Tex., Utah (on some or all spp. listed except (5); Ida., Wash. (4)

End of Malvaceae. Next family in this sequence: Polygonaceae.

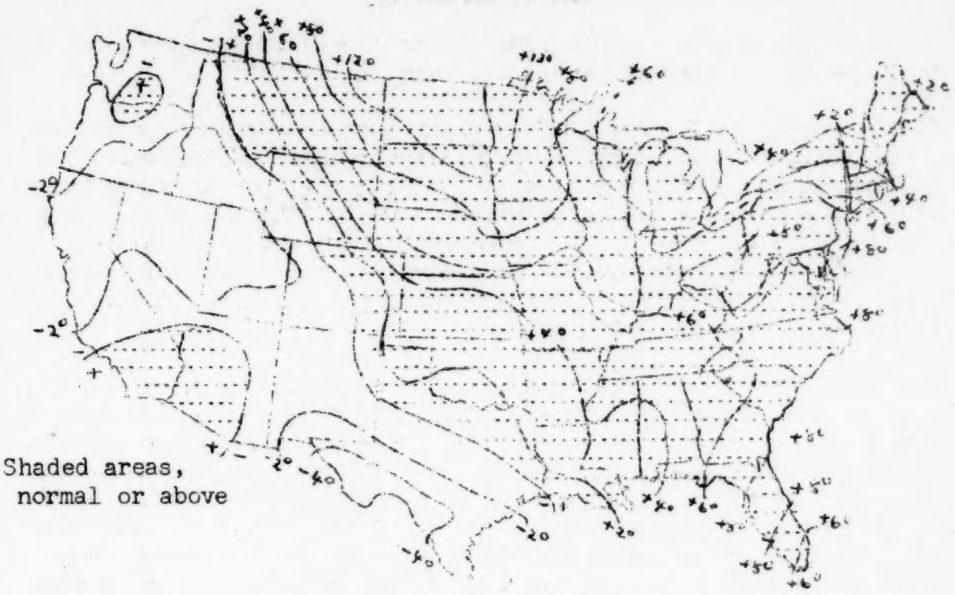
DIVISION OF MYCOLOGY AND DISEASE SURVEY

JANUARY WEATHER

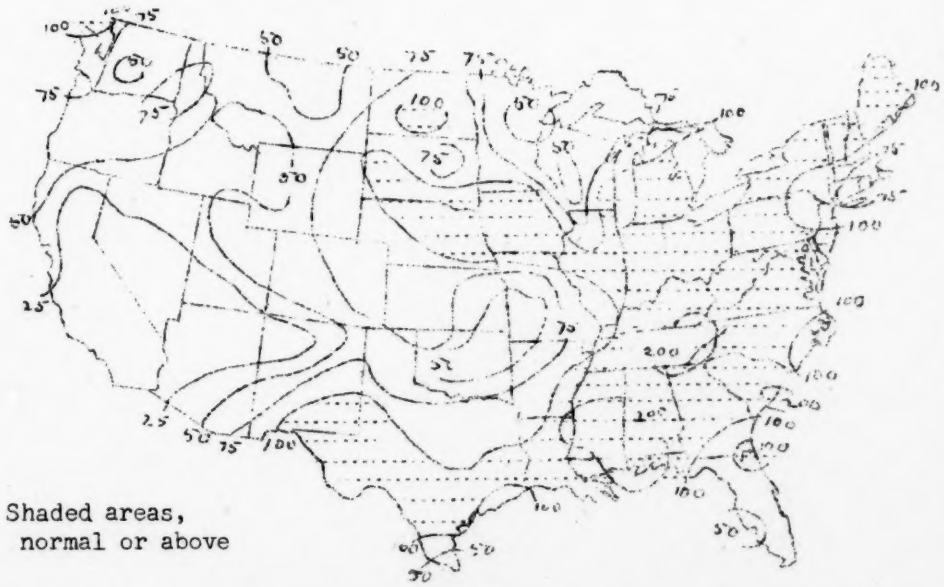
(From U.S. Department of Commerce, Weather Bureau, Weekly Weather and Crop Bulletin for the week ending February 4, 1947.)

Map I shows that January 1947 averaged much warmer than usual over practically the entire portion of the country east of Texas and the Rocky Mountains, with the plus anomalies ranging from 3° along the middle and south Atlantic coast to more than 14° in the extreme northern Plain States. Temperature departures were from 2° to about 6° below normal in southern and southwestern Texas and from the middle Pacific coast eastward over southern Idaho and the Great Basin of the far West.

The total precipitation during last month, as indicated by Map II, was heavy over the eastern third of the country and in south-central Texas, Iowa, and eastern Nebraska; more than twice the usual amounts were reported from sections of Tennessee, Alabama, and Mississippi. Elsewhere totals were below normal, especially in the Florida Peninsula, Missouri, western Arkansas, Oklahoma, the immediate Upper Mississippi Valley, and the far West where many stations received less than one-half their usual amounts. Precipitation in most of northwestern New Mexico, Arizona, the southern Great Basin, and central and southern California was less than one-fourth of normal.



Map I. Departure of mean temperature from the normal, January, 1947.



Map II. Percentage of normal precipitation, January, 1947.